EFFECTS OF DEEP BREATHING EXERCISE ON CARDIOPULMONARY FUNCTION IN THE ADOLESCENTS

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CERTIFICATE

This dissertation entitled "**Effects of Deep Breathing Exercise on Cardiopulmonary function in the adolescents"** is submitted to the Tamil Nadu Dr. M.G.R. Medical University, Chennai, in partial fulfillment of regulations for the award of M.D. Degree in Physiology in the examinations to be held during April 2012.

This dissertation is a record of fresh work done by the candidate **Dr. S. KAVITHA**, during the course of the study (2009 – 2012).

This work was carried out by the candidate herself under my supervision.

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CONTENTS

EFFECTS OF DEEP BREATHING EXERCISE ON CARDIOPULMONARY FUNCTION IN THE ADOLESCENTS

ABSTRACT

Recently, deep breathing exercise(DBE) is used as a non- pharmacological adjunct in the treatment of hypertension, anxiety and diabetes mellitus. The present study was undertaken in 146 student volunteers, doing the first year M.B.B.S course in Tirunelveli Medical College, Tirunelveli in the adolescent age group (17-19 years). The aim was to study the effects of deep breathing exercise on the cardiopulmonary function and to assess the anxiety level by pretest and post-test technique in those individuals, who were trained for doing deep breathing exercise for a period of 12 weeks. The cardiopulmonary parameters include pulse rate(/min) , systolic and diastolic blood pressure (mm Hg) and FVC, $FEV_{1,}$ FEV_1/ FVC, PEF at the beginning prior to the DBE, and at the end of 4, 8, and 12 weeks; and anxiety level in terms of Brief Patient Health Questionnaire (English) before and after DBE. The lung parameters were carried out with a computerized spirometer—Super Spiro. The various data was collected, tabulated, and statistically analysed and all the parameters were found to be highly significant ($p<0.001$). Results indicate that, regular practice of DBE increases parasympathetic

activity and lung compliance. To conclude, this study reveals the usefulness of deep breathing exercise as non-pharmacological adjunct in reducing the anxiety among the students and improving the efficacy of pulmonary and cardiovascular functions.

KEY WORDS Deep Breathing Exercise, Cardiovascular and pulmonary parameters, Anxiety level.

INTRODUCTION

The Modern Age is the age of stress and stress related diseases, are posing a great challenge to the present society[1,2] .The increased standard of living has brought great comfort to mankind; still, the modern man suffers more psychological stress than the physical stress. There is a remarkable transition in the lifestyle pattern of majority of Indians. In today's world, most deaths are attributable to non-communicable diseases (35 million) and just over half of these (17million) occur as a result of cardiovascular diseases[3]. The younger generations in India are, up to 10 times, more prone to cardiovascular diseases as compared to the western countries. Psychological distress due to stress manifest in disrupted breathing, as in the tachypnoea seen in anxiety disorders[1].

The ancient Indian therapeutic traditions as well as modern research have shown, that natural healthy respiration not only increases longevity but also supports our overall wellbeing and self development; slow deep breathing helps in the improvement of medical conditions like asthma, hypertension, anxiety, insomnia etc…[1].Deep slow breathing trials have been published in various journals around the world[4].Studies targeting younger age group provide an estimate of the future magnitude of the problem and assist in developing strategies for applying deep breathing exercise as a non-pharmacological adjunct in the treatment of hypertension, stress related asthma, anxiety, diabetes mellitus etc…Hence, the present study is undertaken.

Aim and objectives

AIM AND OBJECTIVES

1) To assess the cardiovascular and pulmonary function in the selected volunteers of medical students aged 17 to19 years - by the estimation of Pulse rate, Blood pressure, FVC, FEV1, FEV1/FVC ratio and PEF.
2) To **train** the study group **for performing** deep breathing exercise, which has to be done **daily** for a period of 12 weeks.
3) To **repeat** the tests for cardiopulmonary functions, mentioned above, at the **end** of 4, 8 and 12 weeks in the students.
4) To assess the anxiety level in them by **pre-test** and **post-test** by Brief Patient Anxiety Questionnaire (ENGLISH).
5) To record the values in the form of tabular column and
6) To analyze and compare the results obtained.

Review of literature

REVIEW OF LITERATURE

CARDIAC FUNCTION

FUNCTIONAL ANATOMY OF THE CARDIOVASCULAR SYSTEM

Introduction

"**The heart is the beginning of life**; the sun of the microcosm.... for it is the heart by whose virtue and pulse the blood is moved, perfected made apt to nourish, and is preserved from corruption and coagulation; it is the **household divinity** which, discharging its function, **nourishes, cherishes, quickens** the whole body, and is indeed the foundation of life, the source of all action." – **William Harvey**, 1628[5].

The primary role of circulatory system is the distribution of dissolved gases and other molecules for nutrition, growth and repair. **Secondary roles** have also evolved; (1) **Fast chemical signaling** to cells, by means of circulating hormones or neurotransmitters,(2) **Dissipating heat**, by delivering heat from the core to the surface of the body, and (3) Mediating inflammatory and **host defense responses**, against invading micro- organisms.

The circulatory system of human integrates **three basic functional components**: a pump (the **heart**), that circulates a liquid (the **blood**), through a set of containers (the **vessels**). This integrated system, is **able to adapt** to

the changing circumstances of normal life. Demand of the circulation fluctuates, widely between sleep and wakefulness, between rest and exercise, with acceleration / deceleration, during changes in body position or intrathoracic pressure, during digestion, and during emotional or thermal stress. To meet these **variable demands**, the entire system requires sophisticated and **integrated regulation**.

Structure and function of the heart

The heart acts as a **dual pump** that drives the blood in **two serial circuits**- the systemic and pulmonary circulation. The atria are thin walled structures that act as weak priming pumps for the ventricles, which provide most of the energy to the circulation. The interatrial septum separates the two atria. **The right atrium receives de-oxygenated blood** from Superior and Inferior vena cavae and coronary sinus, and Right Ventricle circulates the blood to the **lungs**, where it is **oxygenated**.[Pulmonary Circulation]. **The left atrium** receives **oxygenated blood** from four pulmonary veins - two from each of the left and right lungs and the left ventricle circulates blood to the rest of the body [Systemic Circulation]. **Flow of blood through the heart** is **unidirectional**, which is **achieved by** the appropriate arrangement of **flap valves**.

Cardiac muscle fibers, which make the bulk of atria and ventricles, are arranged in a Latticework and they are striated with typical myofibrils

DIAGRAM 1. STRUCTURE OF THE HEART

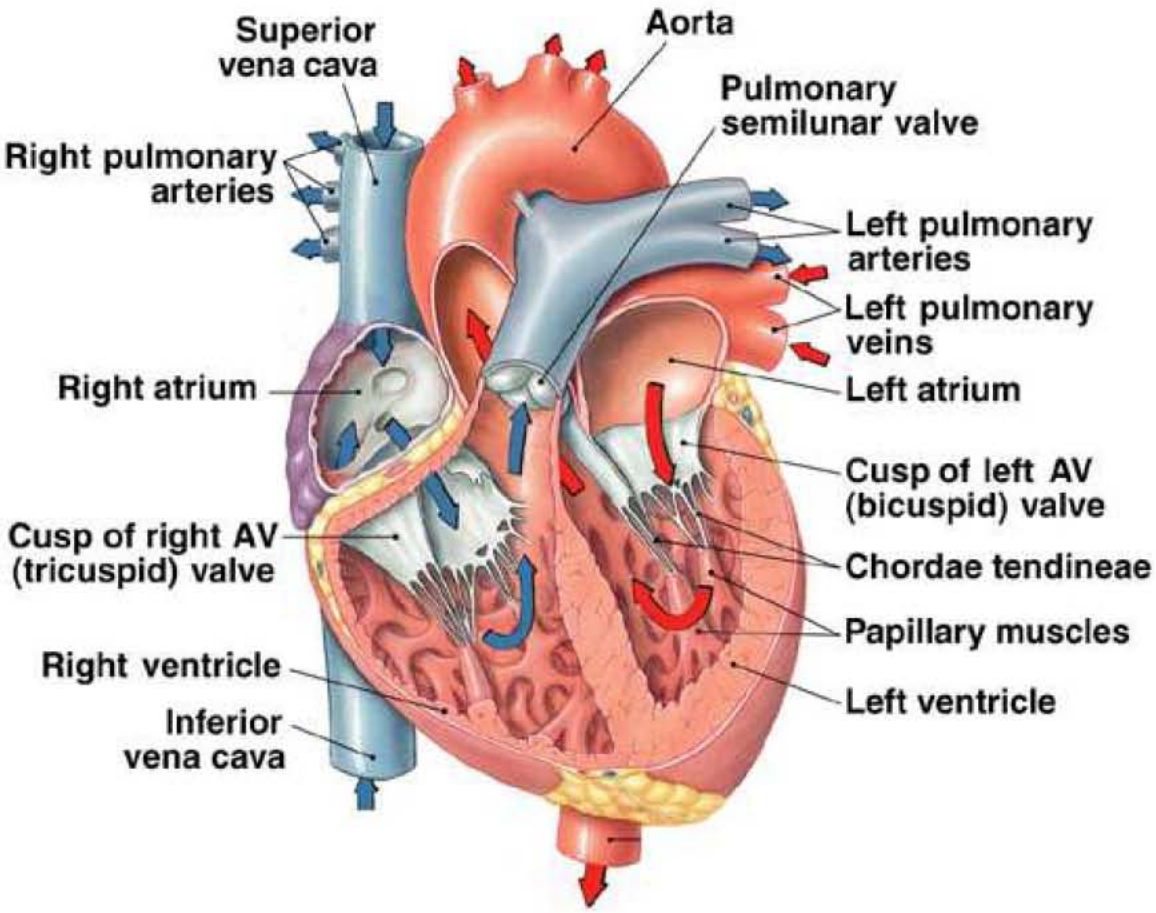
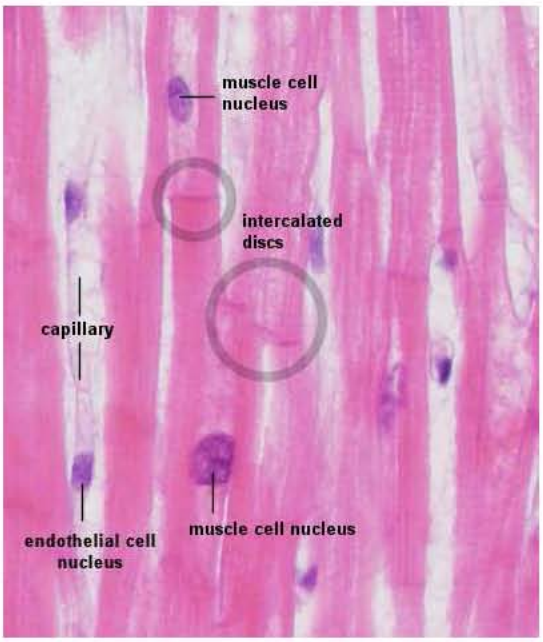


DIAGRAM 2. MICROSCOPIC APPEARANCE OF CARDIAC MUSCLE FIBRE

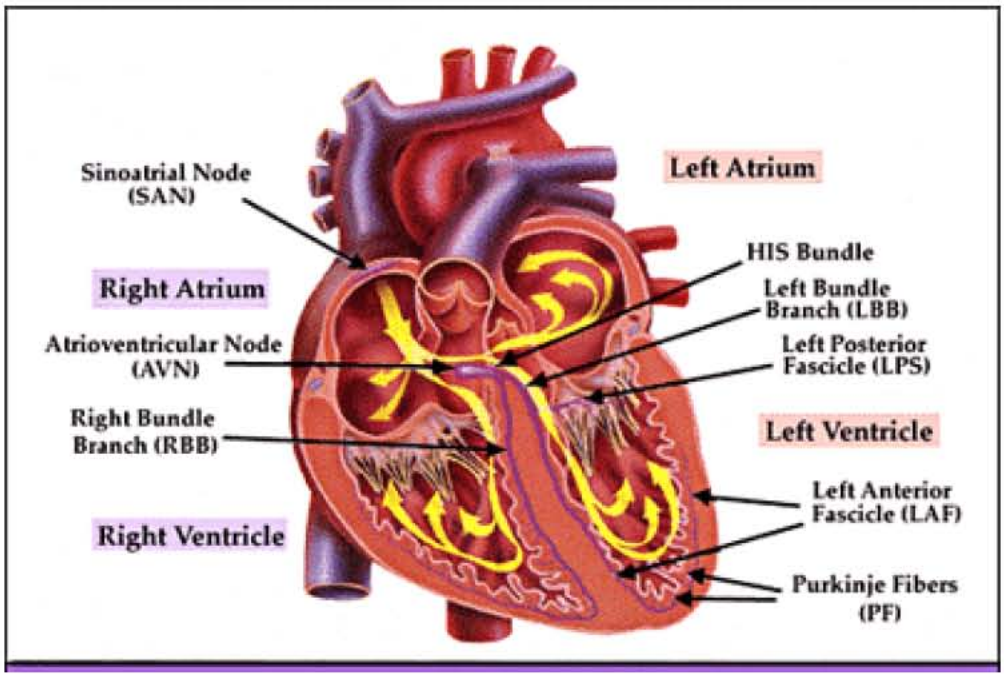


containing actin and myosin filaments. The fibres branch and interdigitate, but each is a complete unit, surrounded by the cell membrane that fuses with one another forming **intercalated disc**. They fuse in such a way, that they form permeable gap junctions that allow, almost totally, free diffusion of ions. Thus, cardiac muscle acts as a **functional syncytium** - atrial and ventricular - allows the atria to contract, a short time ahead of ventricular contraction, which is important for **effectiveness of cardiac pumping**.

Conduction System of the Heart

The heart is made up of **specialized excitatory and conduction system** of the heart, that controls cardiac contractions. The cardiac impulse originates in the SA node and spreads to the atria like ripples of a pond; the internodal pathways conduct the impulse to the AV node and, there is a delay of 0.1 sec at the AV node. AV node continues with the Bundle of His; and it, after penetrating through the atrioventricular septum for 5-15 mm, divides into right and left bundle branches-- the left branch again into Lt Anterior fascicle and Lt Posterior fascicle. Each of three bundles spreads down towards the apex of the heart progressively dividing into smaller branches, which spread the impulse to all parts of ventricular myocardium through **specialized purkinje fibres**. Transmission of the impulse then occurs from endocardium to epicardium.

DIAGRAM 3. CONDUCTION SYSTEM OF THE HEART



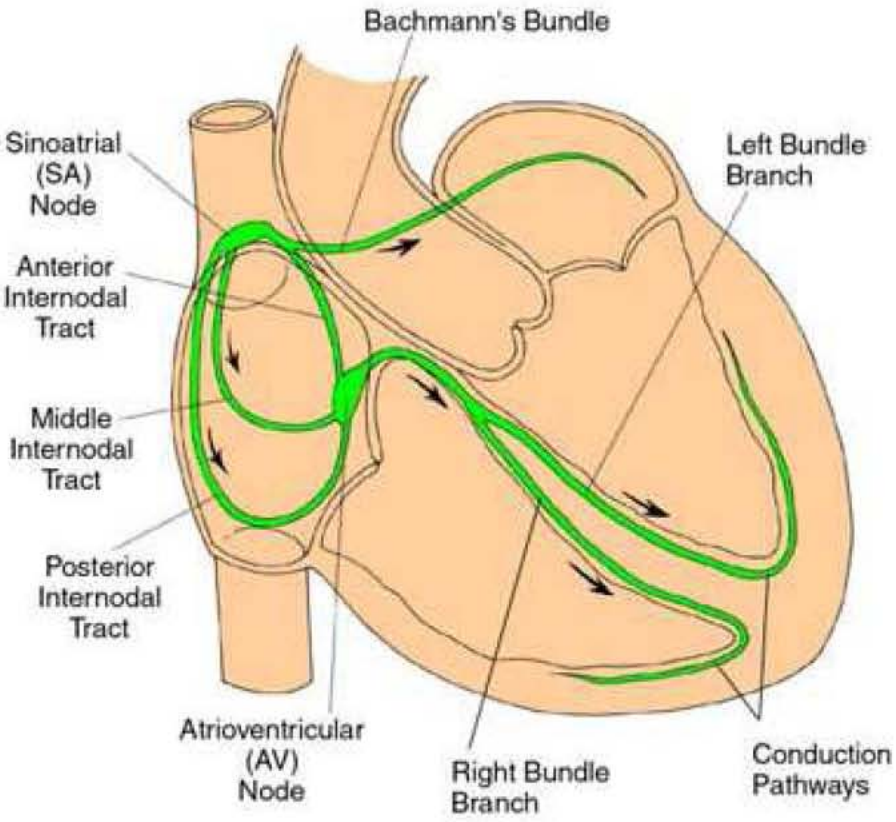
Cardiac impulse

The membrane potential of **pacemaker cells** decays with time (the Pacemaker Potential). Decay is due to multiple inward currents (Na^+ currents i_f, i_b, ca^{2+} currents $i_{ca\text{-}T}$, $i_{ca\text{-}L}$, exchanger current $i_{Na\text{-}ca}$) and a decaying, delayed rectifier K^+ permeability. The potential decay rate determines, the time taken to reach threshold and fire an action potential, which initiates the next heartbeat. **Heart rate is thus controlled by** the slope of **the pacemaker potential**. The nodal action potential is small, sluggish, and generated solely by L-type Ca^{2+} channels[6].

Action of autonomic nerves supplying the heart

Sympathetic nerve fibres release Nor-adrenaline[7], which activates cardiac β_1 – adrenoreceptors . β_1 –activation in the SA node accelerates the decay of the pacemaker potential and thus **increases** heart rate (the **chronotropic effect**) and in atrial and ventricular myocytes **increases force of contraction** (the **ionotropic effect**). Reuptake of free Ca^{2+} by the SR pumps is enhanced, so systole is shortened and relaxation speeded up (the lusitropic effect). The effects of β_1 activation are **mediated through** the adenylate cyclase – cAMP – proteinkinase A pathway. **Parasympathetic fibres** from the Vagi release acetylcholine, which activates muscarinic M_2 – receptor, which **slows the rate** of decay of the pacemaker potential and it also hyperpolarize pacemaker cells. This produces a brisk fall in heart rate. The

DIAGRAM 4. CARDIAC IMPULSE



parasympathetic action is **mediated by inhibition** of the adenylate cyclase – cAMP – PKA chain.

The heart meets increased peripheral demand through increases in heart rate and stroke volume. Stroke volume can be raised by (i) diastolic stretch, which increases contractile force; (ii) catecholamine – mediated increases in contractility; or (iii) a reduction of the arterial pressure opposing ejection.

Frank-Starling Mechanism

Ventricular diastolic stretch is determined by the filling pressure, namely central venous pressure (CVP) on the right and pulmonary venous pressure on the left. Stretch increases the change in the sensitivity of the myocyte contractile proteins to ca^{2+} **leading to a stronger contraction** and increases stroke work (stroke volume x mean arterial pressure). This is called the length tension relation / **Frank starling mechanism** /starling's law of the heart. The Frank starling mechanism equalizes right and left stroke volumes. CVP and therefore stroke volume, is affected by blood volume, gravity, orthostasis, sympathetic mediated peripheral venous tone, the skeletal muscle pump and breathing. An increase in contractile force, which is not due to increased stretch, is called increased contractility or **positive ionotropism**. Increases in contractility shifts the starling curve (Stroke work vs. filling pressure) upwards and to the left. The shift is graded **in proportion to**

sympathetic activity. The normal inotropes are the sympathetic neurotransmitter, Noradrenaline and circulating adrenaline[6].

Vascular system

When the blood is ejected from the heart, the compliant aorta expands to accommodate the volume of blood, and its elastic recoil, sustains blood pressure and flow following cessation of cardiac contraction. The windkessel effect in the arteries, prevents the excessive rise in systolic blood pressure, while sustaining diastolic blood pressure, thereby reducing cardiac after-load and maintaining coronary perfusion.

Now, the blood flows from elastic arteries into muscular arteries, before encountering the **resistance vessels**, namely small arteries and **arterioles**. They act as control conduits through which blood reaches the capillary bed, where there is **exchange** of nutrients, oxygen and waste products of metabolism. **The venules collect the blood** from the capillaries and they gradually coalesce into progressively large veins. **The veins** function as conduits for transport of blood from the venules **back to the heart**.

The pattern of **blood flow is laminar in arteries and veins**, turbulent in the ventricles and bolus (single file) in capillaries. The pressure wave propagates rapidly along the arterial tree, with distal systolic augmentation in

DIAGRAM 5A. VASCULAR SYSTEM

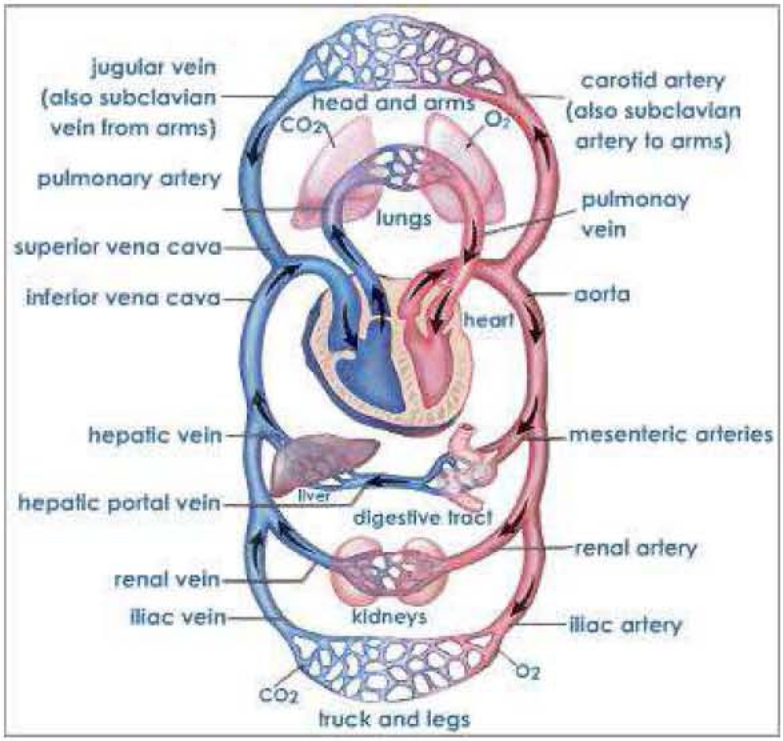
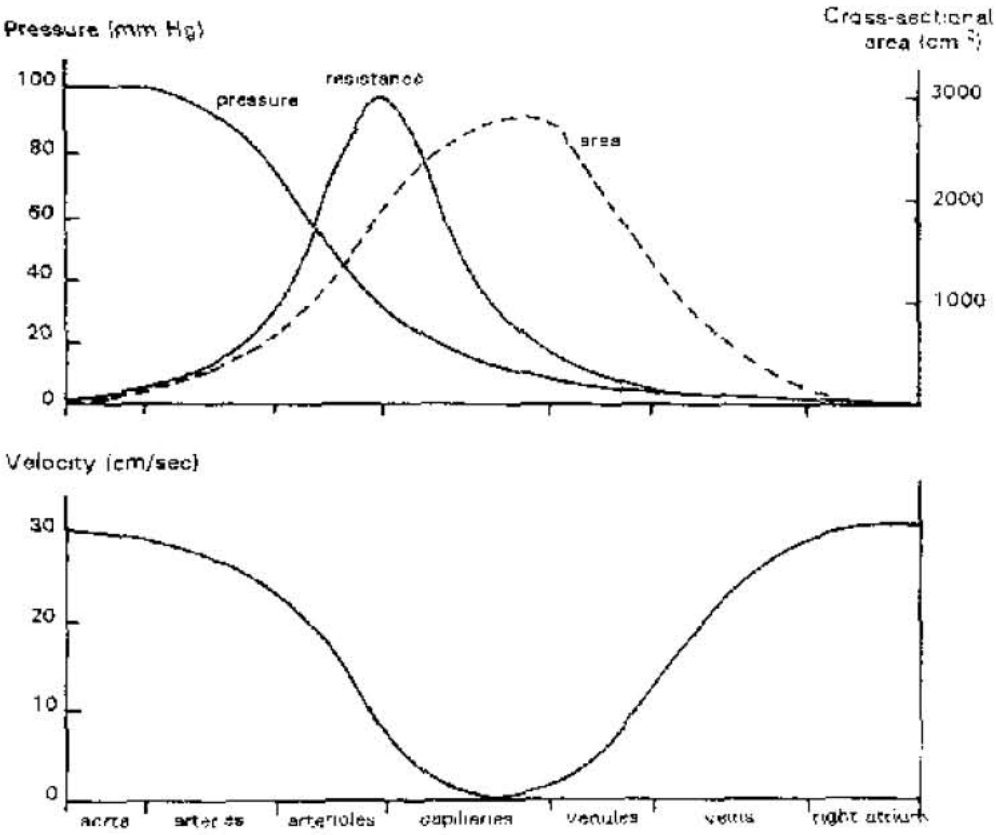


DIAGRAM 5B



young subjects. Arterial stiffening raises cardiac work and oxygen demand. Vascular resistance is located chiefly in the terminal arteries and arterioles, across which the pressure falls from 80mmHg to 35 mmHg. Resistance equals $8\eta L/\pi r^4$, where η is blood viscosity, L is length and r is radius (Poiseuille's Law). Radius is controlled by vascular smooth muscle. Due to the r^4 effect, small increases in vascular tone greatly reduce blood flow, and if widespread, increase the total peripheral resistance and mean arterial pressure. The total cross sectional area of the capillary bed, is very large and the velocity of blood flow is inversely related to the cross-sectional area at any point along the vascular system[6].

Coronary blood flow

The right and left coronary arteries arise from the aorta immediately above the cusps of the aortic valve. The left coronary artery supplies, mainly the left ventricle and septum and the right coronary artery mainly the right ventricle. However, in 50% individuals, the predominant supply is by **right coronary artery**. The coronary circulation is the shortest in the body and its mean transit time is only 6-8s in a resting human.

The coronary circulation must deliver oxygen at a high basal rate, in order to keep pace with cardiac demand. Even in a resting subject, the myocardial oxygen consumption is very high 8ml O_2 per min per 100g. This is 20 times greater than in resting skeletal muscle. During exercise, the

cardiac work rate can increase over five-fold, so the coronary circulation must increase the oxygen delivery correspondingly. The extra oxygen required, at high work rates is supplied chiefly by increased blood flow rather than increased extraction, since extraction is already high(65-75% of the arterial oxygen whereas for the whole body it is 25% at rest) at basal outputs. The energy source of the heart is 2/3rd to 3/4th free fatty acid; the rest is glucose and lactate .The high energy phosphate reserve is low, so increased myocardial performance is tightly dependant on increased coronary oxygen delivery[7,8].

Coronary blood flow is under the influence of physical, neural and metabolic factors, among which metabolic activity of the myocardium plays a key role in determining the coronary blood flow (Shipley and Gregg, 1956).

Nerve Supply of the Cardiovascular System

The heart is innervated by the autonomic nervous system namely, sympathetic and parasympathetic. The parasympathetic fibres originate in the medulla oblongata - Dorsal Nucleus of Vagus. The vagal fibres are distributed on epicardial fat pads near SA node, AV node and atria. The sympathetic fibres arise from intermediolateral columns of upper 5 or 6 thoracic and lower one or two cervical segments of the spinal cord. They are distributed to chambers of the heart as an epicardial plexus and they penetrate the myocardium, accompanying the coronary vessels. Both divisions of

autonomic nervous system tonically influence the cardiac pacemaker as well as the changes in heart rate and force of contraction.

Parasympathetic nervous system inhibits autorhythmicity as well as contractility. In resting healthy conditions, vagal inhibitory activity predominates and the heart rate is slow. It has short latency and duration of action. Sympathetic nervous system enhances autorhythmicity as well as contractility. It is slow to act and has longer duration of action. Adrenergic stimulation associated with emotional stress, exercise, etc... causes the heart rate and force of contraction to increase[8]. If both the divisions are blocked, heart rate in adults is about 100 beats per minute (i.e.) the intrinsic heart rate.[8]

Heart rate and its regulation

It is defined as the number of heart beats per unit of time (expressed per minute). The average resting heart rate is about 70 beats/minute in normal adults. During stress and emotional excitement/muscular activity, it may accelerate to rates well above 100.Heart rate is under the dual control of:1)Regulatory mechanisms intrinsic to the heart and 2) Neural and hormonal pathways that is extrinsic to the heart. The autonomic nervous system is the principle means by which the heart rate is regulated intrinsically. The extrinsic mechanisms are the baroreceptors reflex, respiratory sinus arrhythmia, Bainbridge reflex, atrial receptors, atrial natriuretic peptide, chemoreceptor reflex and ventricular receptor reflex[8].

Blood Pressure

Arterial blood pressure is defined as the lateral pressure exerted by the moving column of blood on the walls of arteries. Since **the cardiac pumping is pulsatile**, the arterial pressure alternates between a systolic pressure of 120 mmHg and a diastolic pressure of 80 mmHg.

In 1733, **Rev.Stephen Hales** measured arterial blood pressure for the first time in his illustrious mare , by inserting a cannula into the carotid artery connected to a manometer. The direct method was first employed in man in 1856, by Favre, a French physician. First successful estimations of arterial pressure in human were performed in England by Mahomed in 1879, and later the technique was perfected by Riva Rocci of Italy in 1896 and **korotkoff** of Russia in 1905.

Determinants of arterial blood pressure

The determinants of arterial blood pressure are divided into a) Physical factors and b) Physiological factors. The physical factors are blood volume and elasticity of the arterial walls. The physiological factors are cardiac output (which equals heart rate × stroke volume) and peripheral resistance. Among these, physiological factors are important, and as cardiac output is the product of stroke volume and heart rate, any factor that affects either of these two parameters affect cardiac output. The stroke volume is affected by

DIAGRAM 6

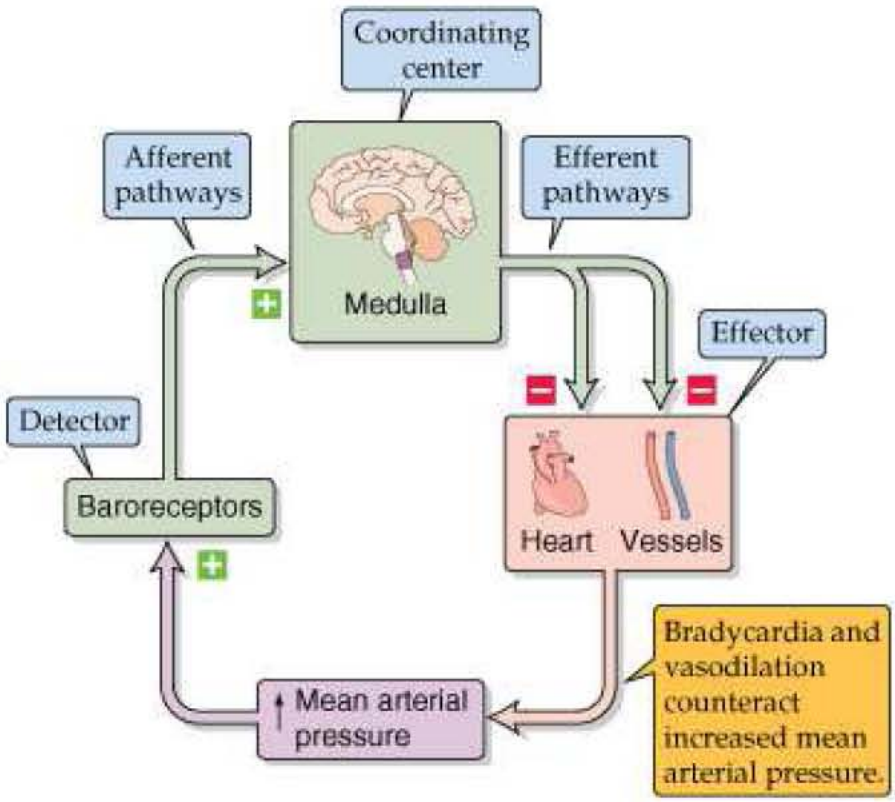
preload, after load and myocardial contractility, and the heart rate is mainly affected by the autonomic nervous system. The changes in cardiac output, mainly affects systolic blood pressure and alteration in peripheral resistance mainly affects diastolic blood pressure. Emotion as well as acute stress, increases the cardiac output and peripheral resistance.

Regulation of Blood Pressure

The blood pressure regulatory mechanisms are divided into: Short-term, Intermediate-term and Long-term processes. Short-term regulation functions from moment-to-moment and minute-to-minute, mainly through baroreceptors, that are present in carotid sinus and aortic arch.They are stimulated by distension of their walls by the pressure inside. They act when there is sudden increase or decrease in blood pressure and restore the blood pressure to the normal levels.

The intermediate and long term regulation of blood pressure involves Capillary fluid-shift mechanism and Renin-Angiotensin-Aldosterone mechanisms.

DIAGRAM 7. REGULATION OF BLOOD PRESSURE



CARDIAC FUNCTION TESTS

The history of the studies on cardiovascular function is a remarkable story with origins in antiquity, centered initially on **clinical observations and palpation of the pulse**. Until the 17th century, the clinical examination consisted of palpation of the pulse; **arterial pulse recordings** were explained by James Mackenzie in his "The Study of the Pulse" (1902)[5, 9, 10.11].

Arterial pulse

The blood forced into the aorta during systole not only moves the blood in the vessels forward, but also sets up a **pressure wave**, that is transmitted along the arteries to the periphery. The pressure wave **expands the arterial walls** as it travels and expansion is palpable as the pulse. Arterial pulse can be palpated from any superficial artery, e.g. radial, femoral, dorsalis pedis and carotid etc... **Most frequently, pulse is examined from radial artery**, because it is conveniently approached without exposing the body and can be easily palpated as it is placed superficially against the bone.

The tracings of arterial pulse can be made by1) Manometric technique, 2) Dudgeon's sphygomograph method- By this technique, we can record : Arterial pulse, jugular venous pulse and heart rate.3) Electronic transducer method.

Normally, in healthy individuals, heart rate equals the pulse rate and hence, we take pulse rate as a measure of heart rate routinely.

Arterial Blood Pressure

The term, blood pressure, refers to the force created by the blood as it passes against and attempts to stretch the walls of blood vessels. The pressure in the aorta and in the brachial and other large arteries in a young adult human rises to a peak value (**systolic pressure**) of about 120mm Hg during each cardiac cycle and falls to a minimum (**diastolic pressure**) of about 70mmHg.The arterial pressure is conveniently written as systolic pressure over diastolic pressure, for example 120/70 mm Hg.

Measurement of Blood Pressure

The blood pressure can be measured by a) **directly** by inserting an arterial cannula into either carotid artery or femoral artery and connecting it to a manometer – the procedure done commonly in animal experiments and b) **indirectly** by using sphygmomanometer. Obviously, the direct method is not suitable as a routine clinical procedure.

The mercury manometer is employed throughout the world to measure the arterial blood pressure in human using **sphygmomanometry**. An inflatable rubber sac within a cotton sleeve called a **Riva- Rocci cuff** is wrapped around the upper arm in such a way that, it is located medially over

the brachial artery and the artery must be at the heart level. The cuff is inflated sufficiently to obliterate the radial pulse and the cuff pressure is measured by mercury manometer. Now, the diaphragm of the stethoscope is placed over the brachial artery in the cubital fossa and no sound is heard, as there is no blood flow. The cuff pressure is gradually lowered at the rate of 2-4 mm Hg per second and at a point, when cuff pressure is just below systolic pressure, the artery opens briefly and turbulent flow of blood causes a tapping sound to appear (**Korotkoff Sound**)- and that pressure, we call it as **Systolic Blood Pressure**. As cuff pressure is lowered further, the korotkoff's sound grow louder and undergoes a series of changes in quality and intensity and at one point, the sound becomes muffled and then disappears. The pressure at this point is noted as **Diastolic Blood Pressure**[6,12].

Other Techniques

1. **Chest x-ray**-to determine the size and shape of the heart.
2. **Electrocardiography**- study of recording of electrical activity of myocardial tissue during each cardiac cycle; can be detected by electrode pairs on the body surface. It is used to assess the cardiac rhythm and conduction and also provides information about the cardiac chamber size.
3. **Echocardiography**- Non- invasive Technique, that uses a Piezoelectric crystal transducer, which emits ultrasound waves at a frequency of 2MHz and is placed on the body surface. The reflected waves (echo) from the

various parts of the heart are detected by the transducer, which acts as a receiver. The reflections are recorded on a photosensitive paper using an oscilloscope. It provides specific and sensitive information about the thickness of the walls of the chambers and septum, chamber diameters and their changes, valve thickness, and volume and velocity of blood flow through the valves(if combined with Doppler technique).

4. **Plethysmography**- Non-invasive technique for measurement of changes in the volume of a limb and thereby, to measure the blood flow.

5. **Recent tests**

   a) Computerized Tomography (**CT**)- Useful for imaging the cardiac chambers, great vessels, pericardium, and mediastinal structures.

   b) Magnetic Resonance Imaging (**MRI**)- Used to generate cross-sectional images of the heart, lungs and mediastinal structure. It provides better differentiation of soft tissue structures.

   c) Single photon emission computed tomography (**SPECT**) and

   d) **Coronary angiography**-to study the coronary vasculature are also used.[13]

PULMONARY FUNCTION

FUNCTIONAL ANATOMY OF RESPIRATORY SYSTEM

Introduction

For millennia, people have regarded breathing as being synonymous with life. **Life begins and ends with breathing**[7]. Respiration includes those processes that contribute to the gaseous exchange- the uptake of oxygen and elimination of carbon-di-oxide – between an organism and its environment. Studies on chemistry of gases by **Boyle, Henry, Avogadro** and others laid the theoretical foundation for the importance of oxygen and carbon-di-oxide in life. Later work by **Spallanzani**, showed that mitochondrial respiration (i.e., the oxidation of carbon containing compounds to form carbon-di-oxide) is responsible for the oxygen consumption and carbon-di-oxide production . This aspect of respiration is often called **internal respiration** or oxidative phosphorylation at cellular level. The **external respiration** involves dual processes of

1) Transporting oxygen from the atmosphere to the lungs.
2) Transporting carbon-di-oxide from the lungs to the atmosphere[7].

Respiratory Tract

The respiratory tract is arbitrarily divided into the upper and lower respiratory tract. The portion which lies above the cricoid cartilage is **the**

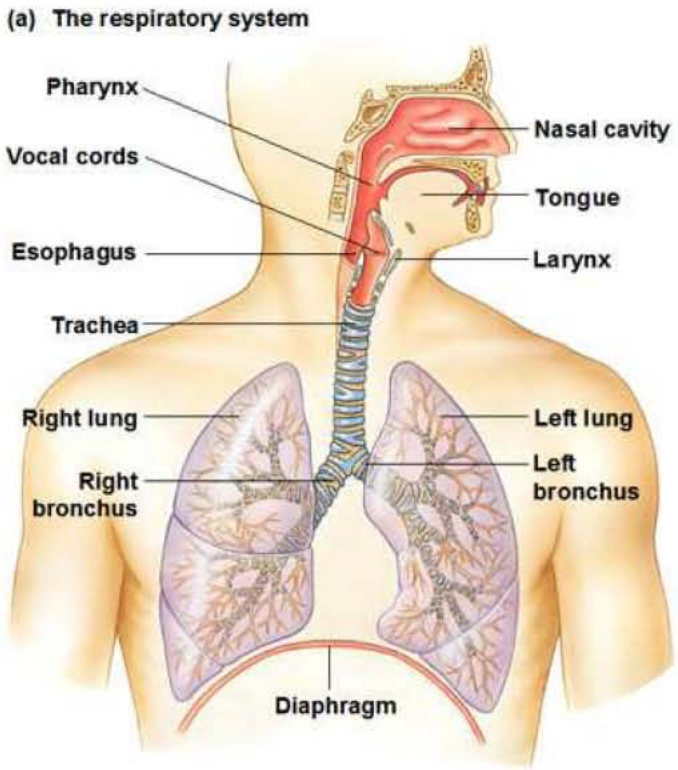
upper respiratory tract which includes nasal airways, posterior pharynx, the glottis, vocal cords and the larynx. The portion which lies below the cricoid cartilage is **the lower respiratory tract** which consists of trachea, two main bronchi, lobar bronchi which in turn divide into segmental bronchi, smaller and smaller bronchioles until reaching the alveoli.[14,15,16]

The **right lung**, located in the right hemi- thorax, is divided into **three lobes** (upper, middle and lower)by two inter-lobar fissures(oblique and horizontal),whereas the **left lung**, located in the left hemi- thorax, is divided into **two lobes** (upper, including the lingual, and lower) by the oblique fissure. Both the lungs are covered by a thin membrane called the **visceral pleura** and are encased by another membrane called the **parietal pleura**, which lines the interior of the thoracic cavity. The region of the lung, supplied by a segmental bronchus is called a broncho-pulmonary segment and is the functional anatomical unit of the lung.

Functions of the respiratory tract

The airways from the nose to the terminal bronchioles are the **conducting airways**, which serve **not only to move the air** into those regions of the lung that participates in **gas exchange**, but also is involved in the **regulation of air temperature and humidity**; also handles the air-borne particles and **removes** large part of the **inhaled harmful** foreign **particles** . At the end of inspiration, the volume of air remaining in the conducting

DIAGRAM 8. FUNCTIONAL ANATOMY OF RESPIRATORY SYSTEM



airways is the **anatomical dead space**, which amounts to 150 ml in healthy young males.

The aggregation of all airways arising from a single terminal bronchiole i.e., the respiratory bronchioles, alveolar ducts and alveolar sacs, along with their associated blood and lymphatic vessels is a terminal respiratory unit, the **fundamental unit of gas exchange**. However, any alveoli that are **ventilated** with air **but not perfused** with pulmonary capillary blood, cannot participate in gas exchange; **so also poorly ventilated alveoli**. Those alveoli are therefore, **referred to as non-functioning alveoli**.

Characteristics of thoracic wall and lungs

Elasticity is a property of matter, which causes it to return to its resting shape, after having been distorted by some external force. **Both the lungs and thoracic wall exhibit elastic recoil**. The interaction between the lungs and thoracic cage determines lung volume. At equilibrium, the inward elastic recoil of the lungs exactly balances the outward elastic recoil of the chest wall. The elastic properties of the lung and its tendency to recoil can be represented by plotting lung volume against the distending pressure. The slope of this **Pressure –Volume Curve is the Compliance of the lung**, which is defined as the volume change per unit of pressure change across the lung.

Volumes and capacities of the lung

The lung volumes and capacities may either be **static or dynamic**, depending on whether or not **time factor** has been taken into consideration.

A] **Static Volumes and Capacities**: These measurements are those, where the time factor is **not taken into consideration** and they are **expressed in litres** and include: 1)Tidal volume, inspiratory reserve volume, expiratory reserve volume and residual volume. 2) Inspiratory capacity, vital capacity, functional residual capacity and total lung capacity.

B] **Dynamic Volumes and Capacities**: Indicate that they are **time-dependent** and **expressed in l/sec or l/min** and include:1) Forced Vital Capacity (FVC), 2) Timed vital capacity (FEV_1),3) Peak Expiratory Flow Rate(PEFR) 4)Maximum Voluntary Ventilation (MVV) and 5) Maximum mid-expiratory flow rate (MMER).[14]

Mechanism of respiration

The muscles of respiration are important components of ventilation. The process of respiration or gas exchange begins with the act of inspiration and **the most important muscle of inspiration is the diaphragm** which consists of thin dome- shaped sheet of muscles inserted into the lower ribs. When it contracts, the abdominal contents are forced downwards and

DIAGRAM 9A. MECHANISM OF RESPIRATION

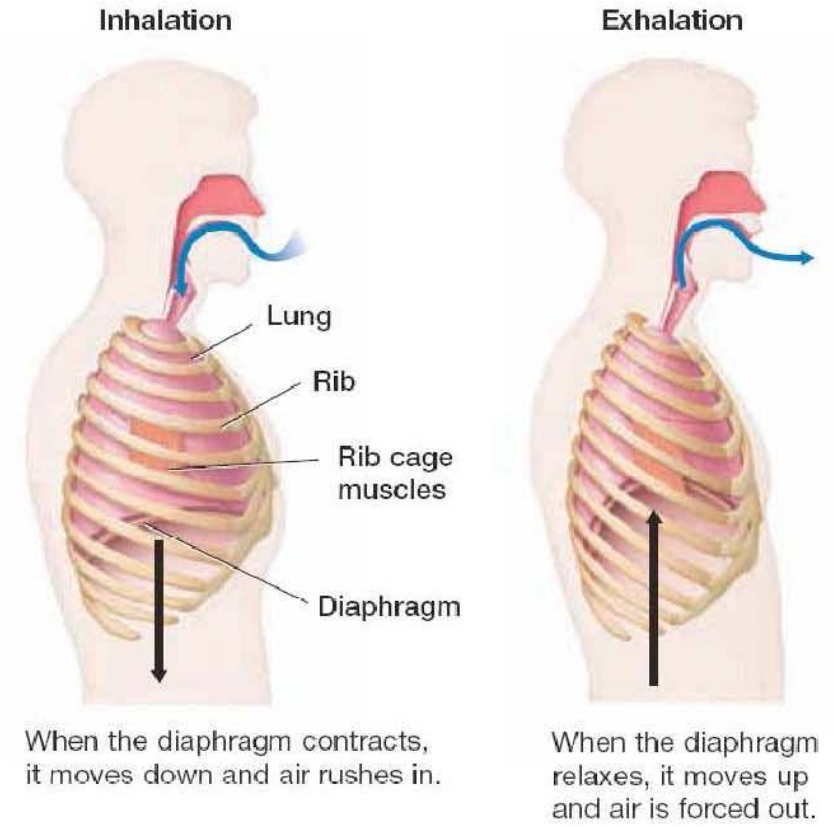
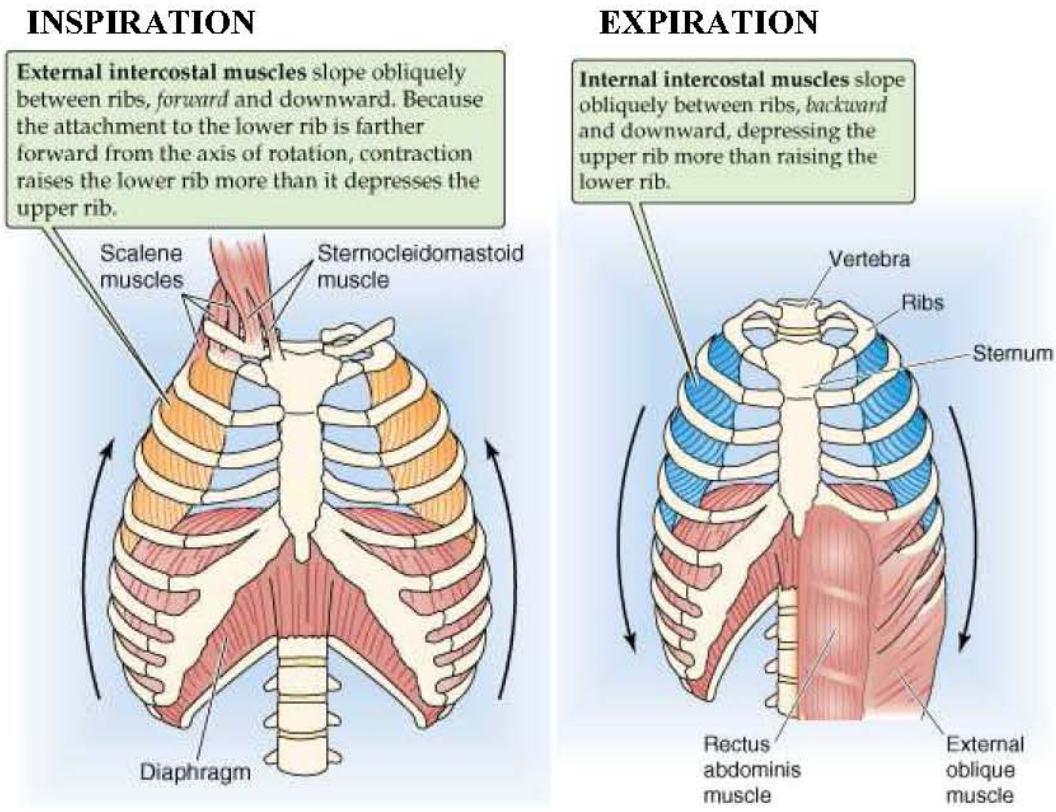


DIAGRAM 9B.



forwards and the vertical dimension of chest cavity is increased and by lifting the rib margins along with external intercostals muscles, the transverse diameter of the thorax is increased. **Expiration, during normal breathing, is passive due to elastic recoil**. But, it becomes active during exercise and hyperventilation.

Airway resistance

It is the **pressure** between the alveoli and the mouth **divided by flow rate**. By direct pressure measurements, it has been shown that the major site of resistance is the medium sized bronchi, and the very small bronchioles contribute relatively little to the resistance. Most of the pressure drop occurs in the airways up to the 7^{th} generation. Small airways (less than 2mm in diameter) contribute only 20 percent of the airway resistance.

Work of breathing

The muscle effort to raise lung volume above Functional Residual Capacity (FRC) during inspiration is a form of work. Part of this is elastic work, used to stretch the tissues and surface lining of the lung and another is frictional work, required to overcome airflow resistance in the airways. The elastic work stored in stretched fibres on inspiration provides the energy required to push air out in the subsequent passive exhalation. Normally, the

energy consumed by the process of breathing is<1ml/min of O_2 consumption for each 1litre/min of ventilation.

Control of respiration

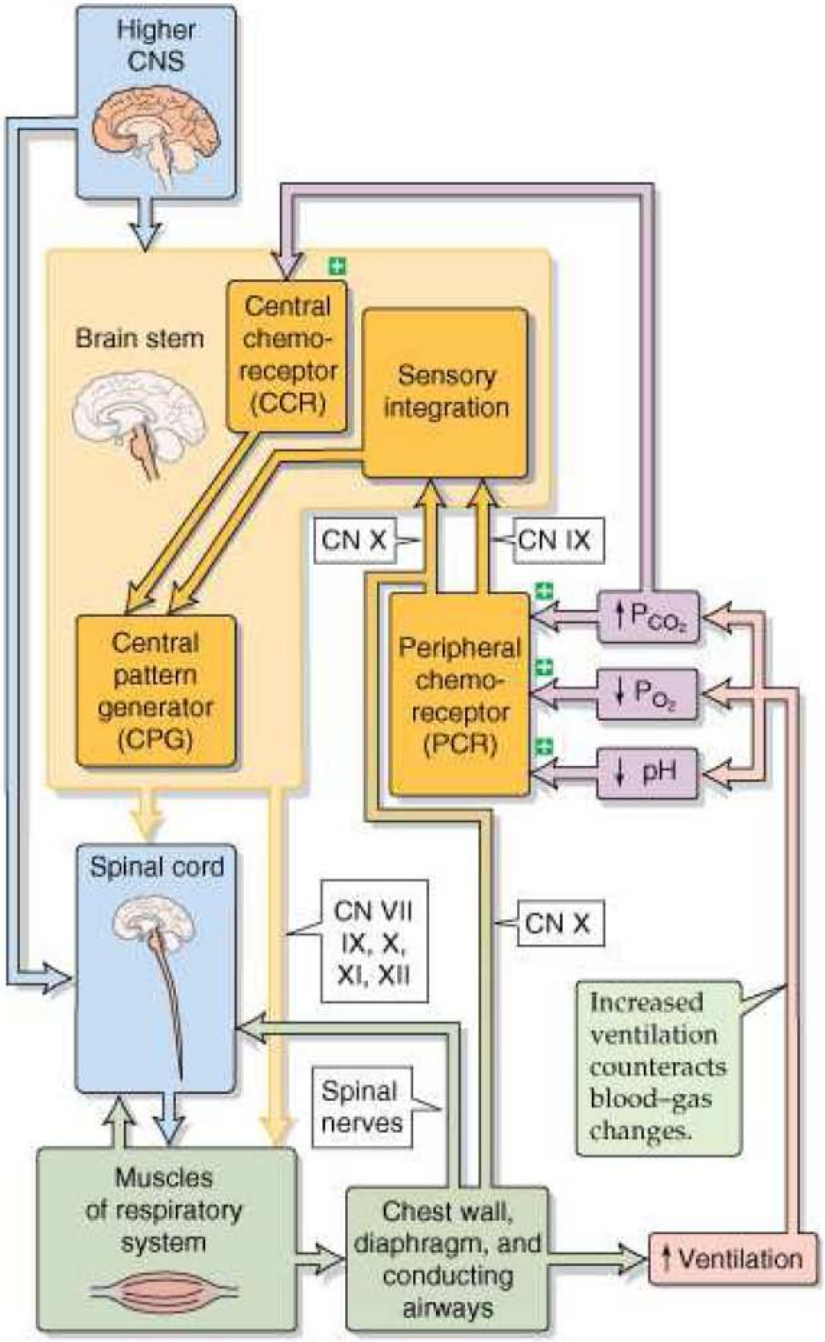
The process of **ventilation is remarkably regulated**, so that arterial Po_2 and Pco_2 are normally kept within limits in spite of widely differing demands of the body as well as changes in the atmosphere. **The respiratory control system consists of three basic elements**

1) Central control situated in the brain stem.
2) Sensors (chemo-receptors and other lung receptors) which gather information about the status of body oxygen and carbon-di-oxide and feed to the central control and
3) Efferent to the Respiratory muscles, which actually bring about the process of ventilation.

The **three form a co-ordinated loop** and a feedback system is developed to bring about a fine control of ventilation.

The **dorsal respiratory group (DRG)** and **ventral respiratory group (VRG)** of neurons in the medulla generate **the basic cyclical breathing pattern**. DRG is composed of cells in the Nucleus Tractus Solitarius located in the dorsomedial region of the medulla. They receive afferent input through

DIAGRAM 10. REGULATION OF RESPIRATION



the 9th and 10th cranial nerves, which carry impulses from airways and the lungs.

The **primary stimulus** for breathing **in healthy** individuals is **arterial CO_2, mediated through the central chemo-receptors** through H^+ formed by the reaction between H_2O and CO_2 molecules. Peripheral chemo-receptors, located mainly in the carotid bodies, respond to arterial O_2.. **The primary stimulus to peripheral chemoreceptor** in healthy individuals is **arterial hypoxemia**, which is not clinically significant until PaO_2 falls **below 60mmHg**.[17]

PULMONARY FUNCTION TESTS

History of PFT

Pulmonary function tests refer to a wide range of diagnostic procedures to measure and evaluate lung function. **Borelli** (1681) is considered to be the first physiologist, who established the **quantity of air** received by a **single inspiration**. In 1700, **Humphrey** measured the **residual volume** by hydrogen dilution technique using his mercurial air holding machine. and this technique was improved by Darling, Cournand and Richards using O_2 breathing to wash nitrogen out of the lungs. The collection of analysis of the volume of exhaled N_2 allowed the Functional Residual Capacity (FRC) to be estimated and in the early 1950s, **Fowler** developed the **single breath N_2 wash out** technique to assess FRC. Using simple spirometry combined with FRC determinations allows Total Lung Capacity (TLC) and residual volume to be calculated. Later, Body Plethysmography which was developed by Comroe and Dubois is used to measure FRC and airway resistance. In 1845,Vieordt did a very exact determination of the volumetric parameters.

John Hutchinson was the **first** person, who started his work with spirometer in 1844. He coined the term **'vital capacity'**, since he realized that compromise of this crucial measurement was predictive of premature morbidity and also, he defined the **functional subdivisions of lung volume**. And after his discovery, there had been various modified forms of spirometer,

which was more simple to use. In 1854, Vintrich developed a modern spirometer and confirmed that body height, weight and age determine the vital capacity. Salter in 1866, added the kymograph to the spirometer, to record time as well as the volume obtained. It was only one hundred years later Hutchinson, Tiffeneau (1947) and colleagues timed the expired volume and described the FEV_1, which has now turned out to be a most widely used parameter to measure mechanical properties of the lungs and medium sized airways. In 1959, Wright B.M and Mckerrow C.B introduced the peak flow meter and later in 1969, DuBois A.B and van de Woestijne K.P presented the whole body plethysmograph on humans and in 1974, Campbell et al presented a cheap and light development of a peak flow meter.

Since 1950s, however pulmonary physiologists took the advantage of the opportunities provided by the growing fields of electronics, transducers and computers, and since then, there has been tremendous progress in the arena of pulmonary function testing. Single breath pulmonary function tests are widely used in the modern computerized age. **Digital spirometry** measures the mechanical function of lungs, chest wall and respiratory muscles by assessing the total volume of air exhaled, from total lung capacity to residual volume. It can graphically display the results and s**how predicted values** and their **interpretations** as required. The unit will have in memory all the prediction tables for males and females across all age groups.There are

a few variables such as age, gender and body size which have an impact on the lung function of one individual compared to another.

In 1831, Thomas Graham of Scotland described diffusion of gases (Graham's Law). The basis for the modern single-breath diffusing capacity (DL_{co}) test was described by August and Marie Krogh in 1911 and later around 1950, Forrester revised the method and they developed it as a tool to measure the gas exchange capacity of the lung. Measurement of blood gases in the blood began since the early 1900s. In 1957, **Sanz** introduced the glass electrode to measure **pH of fluids** potentiometrically, and in 1958, Serveringhaus added an outer jacket containing a bicarbonate buffer to the gas electrode. In 1956, Leland clark covered a platinum electrode with a polypropylene membrane. These three electrodes (pH, pCO_2 and pO_2) were the basic measurement device in blood gas analyzers, which was gradually replaced by Miniature electrodes. In 1967, combined pH-clark-Serveringhaus was developed for rapid blood gas analysis. The ear oximetry was developed in 1974 and **the pulse oximeter** to monitor oxygen saturation in 1980s. Modern microprocesses have allowed pulse oximeters that are capable of measuring COHb in addition to oxygen saturation. To measure the perfusion function of the lung, Swan-Ganz catheter was developed in 1970, for measurement of pulmonary artery pressure and recently, **Lung scan** has become the **routine** to **determine pulmonary blood flow**.[18,19]

Pulmonary function tests are useful 1) To assess **physical fitness** and effects of physical training, 2) as an objective **assessment of the functional status** of the respiratory system and indicate the nature and extent of functional disturbances and, 3) serial measurements are useful in following the course of the disease, evaluating therapy and determining prognosis.[20] Recently Pulmonary function is assessed by the following tests:

I] Tests for ventilation

a. Spirometry: - For assessing Vital capacity (VC), mid-expiratory flow rate (MEFR), peak expiratory flow rate (PEFR), minute ventilation (MV), maximum voluntary ventilation (MVV),
b. Functional residual capacity is determined by single breath nitrogen washout/Helium Dilution Method.

II] Tests for **gas exchange** function- analysis of blood gases using miniature blood gas electrodes (give the value of pO_2, pCO_2 and pH) and pulse oximeters with finger or ear probes for assessment of oxygen saturation.

III] Tests for **Perfusion** function- Lung scan-to determine any blockage in the blood flow from the heart into the lungs and determination of pulmonary vascular pressure by catheterization.

IV] Plain **X-ray** chest – provides information on the **lung fields**

V] Computerized Axial Tomography (**CT**)

VI] Magnetic Resonance Imaging (**MRI**)

VII] Endoscopic Examination: **Bronchoscopy**- for direct visualization of trachea and lower bronchial passages; Histopathological and cytological examination of biopsy material.

MODERN LIFESTYLE CAUSING STRESS CONDITIONS IN DAILY LIFE

In spite of the leaps and bounds in medical sciences, we are surrounded by a very dangerous foe, the life-style disorders. As a result of modern technology and automation, the need for physical activity is reduced and thereby, we lead a sedentary life-style; it was defined as per Centre for Disease Control and Prevention as, no leisure time physical activity or activities done for less than 20 minutes or fewer than 3 times per week.[21] Diseases, directly linked to **modern life-style**, like Diabetes, coronary artery diseases, hypertension, obesity, eating disorders, mood disorders, mental illness and psychosocial disorders are a **great threat** to human life and constitute the major bulk of morbidity and mortality of the 21st century. Our **diet has changed, from high fibre, low fat to high fat, low fibre type and processed food rich in salt and fat content**.[1]

Stress also contributes to the formation of unhealthy life- style habits like overeating, **decreased physical activity**, addiction to smoking, alcohol, **drugs** etc. which lead to obesity, insulin resistance and atherogenic dyslipidemia. Nearly, every man complains of life stress- **Physical stress** from physical overactivity, as well as, mental, **emotional** and psychological **stress at the work place** and in personal relationships with partners, family and friends. Occupational stressors including **long working hours** (Theorell

DIAGRAM 11A. WORK STRESS

T et al.1972)[22,23], shift work (Alfredsson L et al 1982)[24], and high levels of job responsibility (Kittel F et al.1980)[25] may directly contribute to **increased health risks** for cardiovascular diseases and respiratory diseases.

Multinational Time Budget Data Archive and the Australian Time Use Survey suggest that women are now bearing a **Dual Burden** as both **family providers and family carers**. Absence of reciprocal and joint emotion management within family is a nagging stressor for women. For men, workplace stress can have extreme consequences. In Japan, work stress related suicide rate among men has risen over the last 15 years. According to the Government's Statistical Bureau, in Japan, the highest suicide rate occurs in men from 35-44 years old, making it the 13th most common cause of death. Sanjay Chugh, a leading Indian Psychologist, says that 70% to 90% of adults visit primary care Physicians, for work stress- related problems.

DIAGRAM 11B.

EFFECTS OF STRESS ON CARDIOVASCULAR FUNCTION

Among the many different type of stressors, mental and psychosocial stressors, exert profound effects on the circulatory system. **Psychosocial stress** has been demonstrated to increase oxidative stress, which disturbs the endothelial integrity and **induces endothelial injury and dysfunction**. These processes activate beta-1 adrenoreceptors that cause sympathoadrenal activation, which, in turn, enhances atherosclerosis.[26,27] **Mental stress increases the myocardial oxygen demand** via sympatho-adrenal activation and also involves a reduction in the myocardial oxygen supply, an eventually fatal consequence.[26] A possible biological explanation for long working hours eliciting an acute myocardial infarction might be changes in the activity of the autonomic nervous system. **Work-induced tension** that **increases sympathetic nervous activity**, increases blood pressure. Blood pressure is increased in both normotensives and hypertensive subjects. While working the longer the working hours, the higher the daily mean blood pressure. In addition, **reduced activity of the parasympathetic nervous system increases the risk of coronary heart disease**. In particular, mental stress may cause paradoxical constrictions, in patients with CAD/atherosclerosis, especially, at points of stenosis- a response that correlates with the extent of atherosclerosis(plaque) and with the endothelium- dependent response to an

infusion of acetylcholine (verification of endothelial dysfunction).[26,29]An early psychosomatic hypothesis put forth by Alexander(1939) stated that, **feelings of anxiety** might lead to **elevation of blood pressure**, and when prolonged, predisposes to the development of hypertension. A paper from the Framingham Heart Study indicated that, anxiety levels were a significant predictor of the subsequent incidence of hypertension among middle-aged men (Markovitz et al 1993)[30]

Sympatho- adrenergic stimulation is achieved by a combination of

1. Nor-epinephrine released from the terminal neurons of postganglionic fibres running from left or right stellate ganglion.
2. Epinephrine release from adrenal medulla.

Nor-epinephrine excites mainly alpha-receptors, but excites the beta receptors to a lesser extent as well. Conversely, **epinephrine excites both types of receptors**, approximately equally. Therefore, the types of receptors in the organs determine the relative effects of nor-epinephrine and epinephrine. Nor-epinephrine or epinephrine acts on cardiac beta-adrenoreceptors, chiefly beta-1. As a consequence of sympathetic stimulation, the heart rate, rate of conduction and the force of contraction of the heart increases, while the refractory period is reduced[30]. **Sustained stress** may lead to chronic sympathetic arousal and thereby produce vasoconstriction and **lead to hypertension**.

In research conducted by Dr.David Anderson of the National Institute of health, shallow breathing in animals was linked to elevated salt and higher blood pressure. A similar process is suspected to be at play in human. When people are under stress, they tend to take shallow breathes, which in turn makes the blood more acidic and hence, the kidneys are less efficient in removing sodium from the blood.

The studies by Julies et al.1976, have especially well-illuminated the central autonomic involvement of both heart and blood vessels with clear signs of a centrally reduced vagal tone to the heart in association with signs of sympathetic activation.

EFFECTS OF STRESS ON RESPIRATORY FUNCTION

Whenever we are stressed, there is **a shallow and fast breathing** and too much carbon dioxide is lost due to hyper- ventilation; constriction of arteries and arterioles (since CO_2 is a most potent vasodilator) and the suppressed Bohr effect (less oxygen is released in tissues due to increased affinity of oxygen to red blood cells caused by hypocapnia) leading to reduced cells oxygen content. This means that **the heart has to work hard** to attempt **to get oxygen**, when it is needed more in the body and brain. Stressful situations, emotional arousal and psychological stress has been shown to influence our respiratory system, by stimulation of sympathetic nervous system, which produces **adrenaline** and this alters not only respiratory system, but also heart, and other organs. It **increases respiratory rate and respiratory irregularity**.

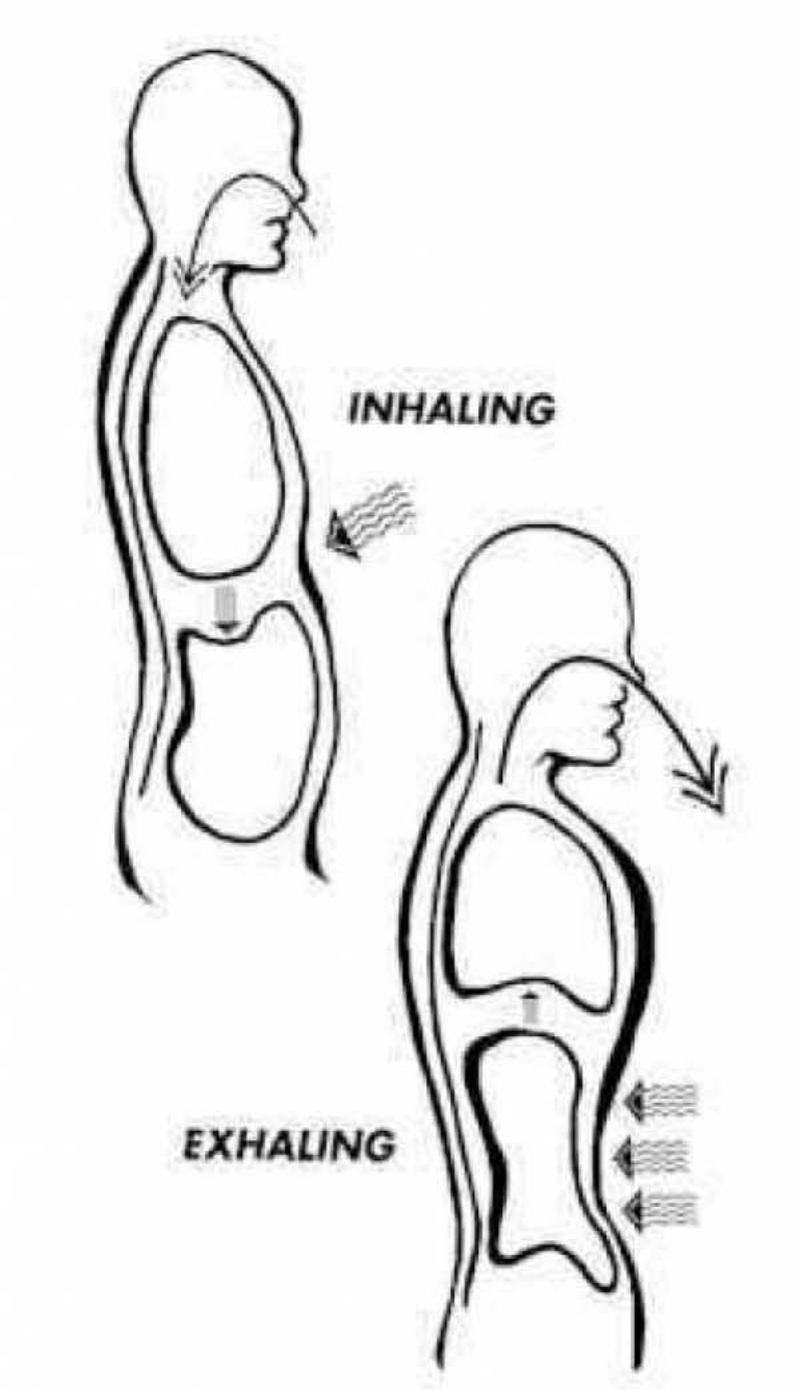
Another important effect of stress on the respiratory system is, **Non-allergic asthma** which does not involve the immune system. It **can be triggered by stress, anxiety**, sadness, smoke or a viral infection. It is also associated with an elevated prevalence of anxiety and depressive disorders. Asthma and these psychological states may mutually potentiate each other, through direct psycho-physiological factors, non- adherence to medical regimen etc. [32, 33,34]

DEEP BREATHING EXERCISE

With our normal **sedentary** way of living, **we use only about one tenth of our lung capacity**. Deep breathing is the act of breathing, done by expanding one's chest and thereby allowing the diaphragm to move down, which becomes flattened (by creating a vacuum that draws the air) creating more room for the lungs to expand rather than only through chest wall expansion/movement of the rib cage. When we exhale, the diaphragm returns to its dome shape, pushing air out of the body, which helps to remove waste products, resulting from body's metabolic processes, while providing oxygen for energy. Deep breathing exercises increases the amount and percentage of air, which enters into the gaseous exchange processes, the alveoli. This **slower, deeper breathing**, combined with the rhythmical pumping of our diaphragm and with the other muscles of respiration, helps to turn on our parasympathetic nervous system - our "relaxation response." Such breathing helps to **harmonize our nervous system** and reduce the amount of stress in our lives. And this, of course, has a **positive impact** on our overall health.

Jerath and colleagues (2006) have reported that, slow deep breathing increases frequency and duration of inhibitory neural impulses, by activating stretch receptors of the lungs; as in Hering-Breuer reflex. Inhibitory impulses, produced by slowly adapting – receptors in the lungs during inflation play a role in controlling autonomic functions such as systemic vascular resistance and heart rate. Inhibitory current synchronizes rhythmic cellular activity

DIAGRAM 12. DEEP BREATHING EXERCISE



between the cardiorespiratory centers and the central nervous system. Inhibitory current regulates excitability of nervous tissue and is known to elicit synchronization of neural elements, which typically is indicative of a state of relaxation. Synchronization within the hypothalamus and the brainstem is likely responsible for inducing the parasympathetic response during breathing exercises.[35]

EFFECTS OF DEEP BREATHING EXERCISE ON STRESS REDUCTION

The increasing stress of modern living makes us breathe more quickly and less deeply. This does not allow enough oxygen to reach the organs and it can cause hyperventilation that result in carbon-di-oxide wash out rather than oxygen uptake. Modern technology and automation reduces our need for physical activity. There is less need to breathe deeply, so we develop the shallow breathing habit. **Deep breathing exercises** and stretching of muscles, especially those primarily concerned with controlling inhaling and exhaling, should be sought. Apart from its health giving benefits, it soothes the nerves and quickly induces the **state of peace and calm**. Deep breathing significantly decreases several negative mood traits, including tension-anxiety in psychiatric inpatients. Relaxation training including deep breathing has been found to be effective in treating stress and anxiety disorders [36] and is therefore an alternative treatment for anxiety. Oxidative stress may contribute to pathophysiology of many chronic diseases such as psychosocial stress. A study using stress reduction from slow deep breathing exercise revealed significantly lower levels of lactate and higher levels of superoxide dismutase, glutathione and catalase compared with controls . In another study, hemodynamic response to acute stress to healthy volunteers, revealed significantly positive effect when slow deep breathing technique was positively applied. [37]

EFFECTS OF DEEP BREATHING EXERCISE ON CARDIOVASCULAR FUNCTION

The cardiovascular system is controlled mainly by the autonomic nervous system. Baroreceptors are branched and myelinated nerve endings, that are present in the carotid sinus and aortic arch, which respond to changes in blood pressure, whenever there is variation in blood pressure over a wide range of 60-180 mm Hg. It sends impulses to the cardiac centre in the brainstem via afferent fibres in the glossopharyngeal and vagus nerve .At the normal blood pressure there is impulse discharge in these nerves at a low frequency and is responsible for vagal tone.[38] **Baroreflex sensitivity** can be **enhanced** significantly by slow deep rhythmic breathing, by stimulating the medullary cardio-inhibitory area and that leads to **reduction in sympathetic activity** that inhibits the tonic discharge of the vasoconstrictor nerves and excites the vagal innervations of the heart. As the sympathetic activity to the heart is reduced, it leads to decrease in heart rate i.e decrease in work of the heart , leading to fall in systolic blood pressure. As the vasoconstrictor fibres supplying the resistance vessels i.e. the arterioles are inhibited, it leads to widespread vasodilatation and hence **fall in diastolic blood pressure**.[39] Thus, slow deep breathing alters the heart rate, strength of cardiac contractions, and diameter of blood vessels.

Deep breathing leads to a greater pressure differential in the lungs, which leads to an increase in the circulation **with increased oxygen level** in the blood, that can **increase the efficient functioning of the heart**.[38]

EFFECTS OF DEEP BREATHING EXERCISE ON RESPIRATORY FUNCTION

During deep breathing exercise, there is increase in alveolar ventilation that favours diffusion of oxygen and hence oxygenation of the tissues is also greater. The **shallower** the **breathing**, the **larger** becomes the **percentage of dead air** in each breath. Deep breathing has the effect of increasing both the amount and percentage of air, which enters actively into the gaseous exchange processes. Deep breathing exercises **increase the elasticity of the lungs** and **rib cage** and also causes **enhancement of respiratory muscle efficiency**. Stimulation of pulmonary stretch receptors by deep inspiration causes reflex relaxation of smooth muscles of the larynx and tracheobronchial tree and that modifies the airway caliber, thereby **reducing airway resistance**.[40] This creates an increased breathing capacity all day, not just during the actual breathing period. This means all the above benefits also occur all day and hence protect the individuals from respiratory illness.

Materials and Methods

MATERIALS AND METHODS

STUDY DESIGN : This is an interventional trial.

STUDY PLACE AND STUDY PERIOD : This study was conducted in the Department of Physiology, Tirunelveli Medical College, Tirunelveli. The study period extended from November 2010 to February 2011.

STUDY SUBJECTS : 146 student volunteers, doing the first year M.B.B.S course in Tirunelveli Medical College, Tirunelveli in the adolescent age group (17-19 years) were selected for the study.

INCLUSION CRITERIA : Healthy volunteers of both sexes in the age group of 17-19 years.

EXCLUSION CRITERIA : Students suffering from any respiratory illness like bronchial asthma, physically handicapped-any chest/spinal deformity.

MATERIALS USED FOR THE STUDY

- Proforma- to record the details of the subjects and to record the clinical findings.
- Standardised mercury sphygmomanometer-to record the Blood pressure.
- Portable weighing machine-to record the body weight in kilograms.
- Digital spirometer- to measure the lung function tests.

METHODOLOGY

The study was approved by the Ethical Committee of Tirunelveli Medical College, Tirunelveli. **After getting** the **informed** written **consent** from the individuals, the **proforma** for details such as age, sex, height, weight, hours of active exercise, menstrual history (in case of women) was **filled up**. A thorough clinical examination of the study subjects was done.

The following parameters were measured in the selected group for assessing the cardiovascular and pulmonary functions- Pulse rate (/min), Blood pressure (mmHg), FEV_1 (L), FVC (L), FEV_1/FVC (%), PEF (L/min). These tests were recorded in batches of 25 students daily for 6 days.

The **anxiety level** of the students was assessed by **pretest technique**, with the help of **Brief Patient Health Questionnaire (English)**, a version of Patient Health Questionnaire (PHQ) Family of Measures[41, 42, 43]. It was designed by Drs.Robert L.Spitzer et al 1999.It consisted of 7 questions and the anxiety level is calculated by assigning scores of 0,1,2, and 3 to the response categories of 'Not at all', 'Several days', 'more than half the day, and 'nearly every day' respectively. Total score for the seven items ranges from 0-21.Students were asked to answer the 7 questions in the format to the best of their knowledge. The **scores were calculated** for each individual and those with 1-5, 6-10, and 11-15 were said to have **mild, moderate** and **severe** anxiety respectively.

The students were trained for performing deep breathing exercise, and they were requested to do the same daily for a period of 12 weeks. They were asked to sit upright comfortably with eyes closed, and they were instructed to take a slow deep breathing (which includes inspiration and expiration), that was continued for 15 minutes in the morning session, in the presence of instructor from 11 AM to 11.15 AM, and they were asked to repeat the same procedure for 15 minutes in the evening at their convenient time. Thus, the procedure was done for 30 minutes/day, for a period of 12 weeks.

The various tests for assessing the cardiovascular and pulmonary functions were carried by the procedures mentioned below and repeated at the end of 4 weeks, 8 weeks and 12 weeks; Recording of the Pulse rate, Blood Pressure and Spirometry was done in batches of 25 students daily, for 6 days-146 students totally and the **anxiety level** was analysed by **post-test technique** at the end of 12 weeks. The above parameters were recorded in the proforma and then tabulation was done separately. The **results** were then **compared, analyzed statistically** to find out the significance of variations in them, before and after deep breathing exercise.

1. Measurement of pulse rate

The arterial pulse rate, (which is an indirect indicator of the heart rate in a healthy individual), was measured by the examination of the radial artery. The radial pulse was best felt with the tips of the three middle fingers

RECORDING OF PULSE RATE

RECORDING OF BLOOD PRESSURE

with the forearm of the subject in semipronated position and the wrist slightly flexed. The counting was not done, as soon as the fingers were first laid upon the pulse, but only when it had resumed to normal rate; it was counted for one minute and was expressed as pulse rate/minute.[12]

2. Measurement of Blood Pressure

The arterial blood pressure was measured by the **non-invasive technique** using **sphygmomanometer** by auscultatory method (Russian Physician, Korotkoff,1905). A Hawksley random–zero sphygmomanometer (Gelman Hawksley, Northampton) was used for all, recording with a cuff (Riva-Rocci cuff) of appropriate size (for adults-23×12.5 cm) as proposed by Long et al. Blood Pressure was recorded by asking the student to sit comfortably in a chair and the uninflated cuff was wrapped firmly around the upper left arm (as recommended by Rose and Blacksmith[44]), 2.5-3cm above the elbow and the chest piece of stethoscope was kept at the elbow medial to the tendon of biceps, where pulsations of brachial artery was felt. Now, the cuff was inflated rapidly until the pressure in it was well above the systolic blood pressure i.e.30mm Hg above the level at which radial pulsation is no longer felt (as measured by the palpatory method) and gradually the cuff pressure was lowered by opening the valve till a clear, **sharp, tapping sound** was heard with the stethoscope (corresponds to korotkoff's phase 1) and the pressure at this moment was taken as **Systolic Blood Pressure.** The pressure

SPHYGMOMANOMETER

in the cuff was progressively lowered (at 2-3mm Hg/sec) and at the same time listening to the muffling/disappearance of sound, the pressure was noted (corresponds to Korotkoff's Phase4/5 respectively) and it was taken as **Diastolic Blood Pressure**.

3. Measurement of

[a] Forced Vital Capacity

[b] Forced Expiratory Volume in first second

[c] FEV_1/FVC ratio and

[d] Peak Expiratory Flow Rate.

were done using Computerised Spirometer- Super Spiro.

The Micro Medical Super Spiro (Micro Medical, Rochester, Kent, England) consisting of a (1) microcomputer unit incorporating a 1/4^s d A screen with 64 colour display with touch screen,data entry keypad and all associated circuitry, (2)digital volume transducer, (3) transducer holder and, (4) mains adapter. The Micro Medical Digital Volume Transducer, which measures expired air directly at B.T.P.S (Body Temperature and Pressure with Saturated water vapour), thus avoiding inaccuracies of temperature correction.[45]

DIGITAL SPIRO METER – SUPER SPIRO

RECORDING OF FEV_1, FVC, FEV_1/FVC, PEF

Preparation of the student for spirometry: **Preparation consists** mainly of **instructions** given to them in advance of the actual test session. To obtain valid data, they were instructed to refrain from vigorous exercise immediately before testing and to be **relaxed** and **comfortable** during the test session. Demonstration of the procedure was given at the start of test session.

The test was done in the sitting position with the head slightly elevated. The individual was instructed to take deep inspiration, until their lungs were completely full, then seal their lips around the mouth piece and **blow out as hard and as fast as possible**, until they cannot push any more air out (at least for a minimum of 6 seconds). Then to breathe in fully, immediately after the expiratory maneuver, thus completing the flow volume loop. Instruction about maintaining a good seal on the mouth piece was given[46].By this maneuver, the flow-volume loop was displayed on the computer monitor screen. The computer analyses the signal from the spirometer, then calculates and displays the FVC,FEV_1, FEV_1/FVC, and PEF. The procedure was repeated up to 3 times and best of the three was taken as the final reading.[19]

- **Forced vital capacity (FVC)**

Defined as the maximum volume of gas that can be expired, when the patient exhales as forcefully and rapidly as possible, after a maximum inspiration.

- **Forced expiratory volume in one second (FEV_1)**

Defined as the volume of air which can be forcibly exhaled from the lungs in the first second of a Forced expiratory maneuver.

- **FEV_1/FVC ratio- FEV_1%**

Indicates what percentage of the total FVC is expelled from the lungs during the first second of forced exhalation. The normal values of FEV1% are 80-85% in young adults.

- FVC and FEV_1 are both expressed in litres. FVC, FEV_1 and FEV_1% are reliable indices of ventilator capacity and indicator of pulmonary ventilation.

- **Peak Expiratory Flow Rate (PEFR/PEF)**

Defined as the maximum rate of air flow achieved during the FVC maneuver, beginning after full inspiration and starting and ending with maximal expiration. It is expressed in L/min. Normal Range- 350-600 litres per minute.[46]

PROFORMA

EFFECTS OF DEEP BREATHING EXERCISE ON CARDIOPULMONARY FUNCTION IN ADOLESCENTS

No: AGE:

NAME : SEX:

ADDRESS: PARENT'S INCOME:

HEIGHT: cm WEIGHT: kg

PERSONAL HISTORY: Hours of active exercise

Menstrual history (in case of women)

O/E: GENERAL EXAMINATION-

SYSTEMIC EXAMINATION: CVS

RS

EXAMINATION OF CARDIOVASCULAR & RESPIRATORY SYSTEM

S. No	Tests Done	Initial reading	End of 4 weeks	End of 8 weeks	End of 12 weeks
1.	PR(/min)				
2.	BP(mm Hg)				
3.	FEV1(L)				
4.	FVC(L)				
5.	FEV1/FVC (%)				
6.	PEF(L/min)				

INFORMED CONSENT:

I consent for this study having been informed about the procedure.

BRIEF PATIENT HEALTH QUESTIONNAIRE (ENGLISH)

Over the last 2 weeks, how often have you been bothered by the following problems? (Use "√" to indicate your answer)	Not at all	Several days (less than half the days)	More than half the day	Nearly everyday
a. Feeling nervous, anxious or on edge				
b. Not being able to stop or control worrying				
c. worrying too much about different thing				
d. Trouble relaxing				
e. Being so restless that it is hard to sit still				
f. Becoming easily annoyed or irritable				
g. Feeling afraid as if something awful might happen.				

Results Analysis

RESULTS ANALYSIS

The results obtained after the performance of the tests to assess the cardiovascular and pulmonary functions in the study group were tabulated. The findings were compared with reference to the age and the effects of the deep breathing exercise at the intervals of 4, 8, and 12 weeks; the anxiety level assessed by pre-test and post-test were also analysed and compared.

The statistical analysis of the results was also undertaken. All the values obtained before and after performing Deep Breathing Exercise, were expressed as mean ± S.D. The results were analyzed and interpreted by repeated measures of ANOVA and the student's paired t test was used to compare parameters within the study group. The above statistical procedures were performed with the help of statistical package namely PASW Statistics-18 (Predictive and analysis software).

TABLLE.1

AGE & SEXWISE DISTRIBUTION OF THE STUDY GROUP

AGE (YEARS)	MEN	WOMEN	TOTAL
17	23	46	69
18	30	32	62
19	4	11	15
TOTAL	57	89	146

Among the 146 students in the study group, 57 are men and 89 are women.

TABLE.2

EFFECT OF DEEP BREATHING EXERCISE ON ANXIETY LEVEL.

	NO ANXIETY	MILD ANXIETY	MODERATE ANXIETY	SEVERE ANXIETY	TOTAL
PRE TEST	2	80	53	11	146
POST TEST	24	112	9	1	146

The facts that the number of students with no anxiety level has increased from 2 to 24 and the number of students with moderate and severe anxiety level has been reduced markedly (after 12 weeks of DBE), show the response due to deep breathing exercise among them. The same was analysed statistically and the changes were found to be highly significant.

STATISTICAL ANALYSIS

	Anxiety Level	**P value**	**Significance**
	Mean ± S.D		
Initial Reading	5.5 ± 3.3	<0.001	Highly Significance
End of 12 Weeks	1.7 ± 1.2		

Figure – 1

EFFECT OF DEEP BREATHING EXERCISE ON ANXIETY LEVEL

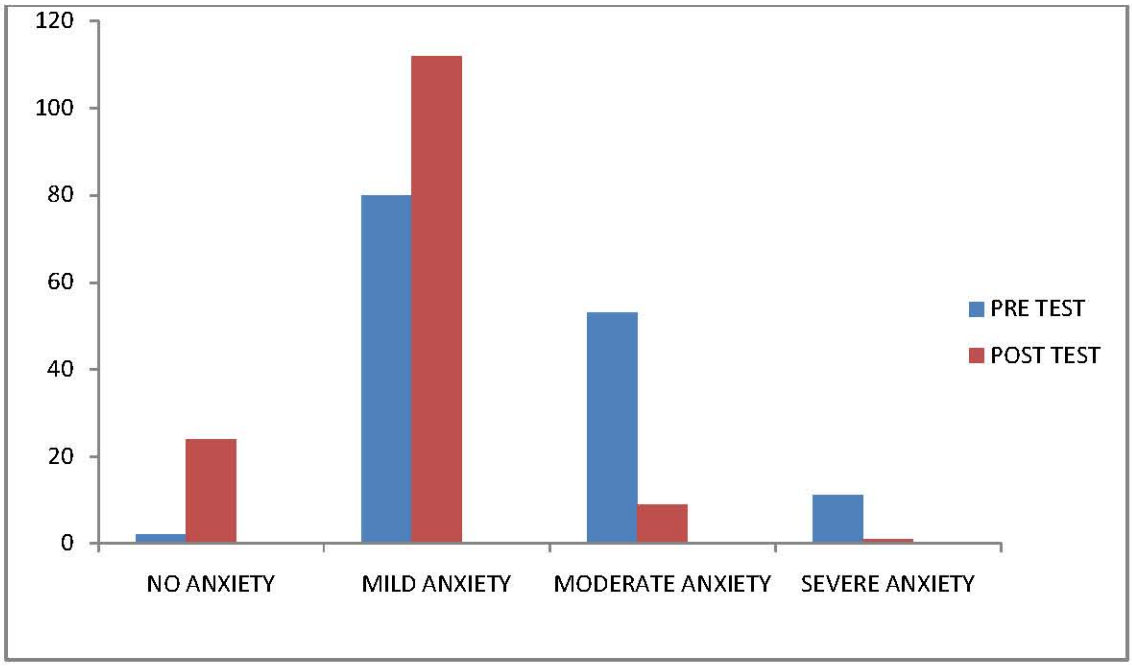


TABLE.3

VARIATION IN PULSE RATE BEFORE AND AFTER DBE*

Age in Years	No. of students	Average pulse rate/min			
		Initial reading	At the end of		
			4 weeks	8 weeks	12 weeks
17	69	96.29	89.18	85.62	82.68
18	62	93.12	86.51	83.64	81.19
19	15	95	85.33	81.46	80.40

There is a gradual decrease in pulse rate/min following the deep breathing exercise and it is found to be statistically significant ($p<0.001$).

STATISTICAL ANALYSIS

	Pulse Rate (/min) Mean ± S.D	F value (ANOVA)	P value	Significance
Initial reading	94.8 ± 10.9	165.090	< 0.001	Highly significant
End of 4 weeks	87.6 ± 11.3			
End of 8 weeks	84.0 ± 9.6			
End of 12 weeks	81.4 ± 8.9			

*DBE – Deep Breathing Exercise

FIGURE. 2

EFFECT OF DEEP BREATHING EXERCISE ON PULSE RATE

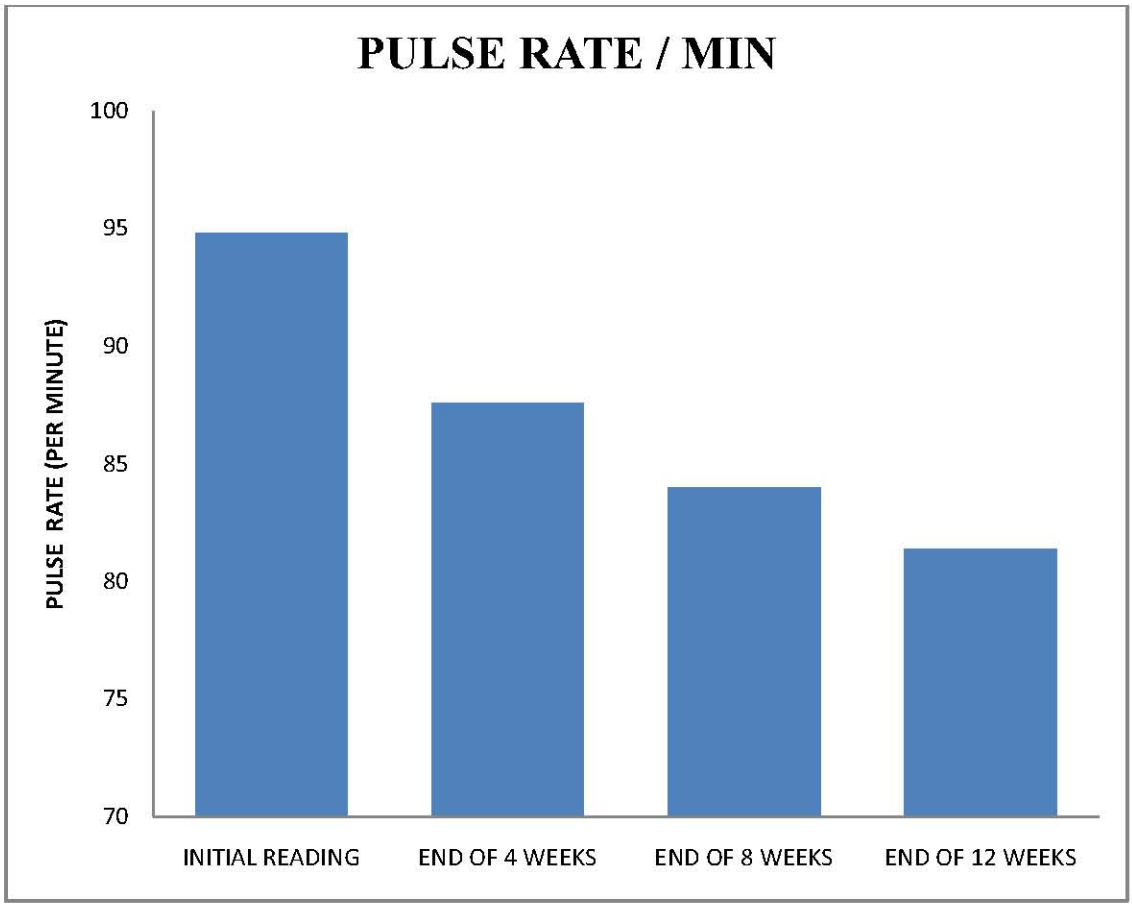


TABLE. 4

VARIATION IN SYSTOLIC BLOOD PRESSURE BEFORE AND AFTRE DBE.

Age in years	No. of students	Average Systolic Blood pressure in mmHg			
		Initial reading	At the end of		
			4 weeks	8 weeks	12 weeks
17	69	120	112.92	109.33	108.20
18	62	119.29	114.32	113.16	109.64
19	15	125.19	118.	117.33	114

There is a gradual reduction in systolic blood pressure (mm Hg) following the deep breathing exercise and statistically it is found to be highly significant. ($p<0.001$).

STATISTICAL ANALYSIS

	Systolic blood pressure (mm Hg) Mean ± S.D	F value (ANOVA)	P value	Significance
Initial reading	120.3 ± 13.6	67.882	< 0.001	Highly significant
End of 4 weeks	113.3 ± 12.2			
End of 8 weeks	112.5 ± 12.2			
End of 12 weeks	110.1 ± 14.2			

TABLE. 5

VARIATION IN DIASTOLIC BLOOD PRESSURE BEFORE AND AFTER DBE

Age in years	No. of students	Average Diastolic blood pressure in mm Hg			
		Initial reading	At the end of		
			4 weeks	8 weeks	12 weeks
17	69	80.81	76.69	74.43	72.52
18	62	80.77	75.77	74.38	72.41
19	15	83.06	78.53	77.73	73.73

Following the deep breathing exercise, there is a gradual decline in diastolic blood pressure (mm Hg), which, when analysed statistically is highly significant. ($p<0.001$).

STATISTICAL ANALYSIS

	Diastolic blood pressure (mmHg) Mean ± S.D	F value (ANOVA)	P value	Significance
Initial reading	81.2 ± 10.4	49.666	< 0.001	Highly significant
End of 4 weeks	77.5 ± 12.5			
End of 8 weeks	74.7 ± 7.8			
End of 12 weeks	72.5 ± 7.8			

TABLE.6

VARIATION IN FVC* (L) BEFORE AND AFTER DBE

Age in years	No. of students	Average FVC (L)			
		Initial reading	At the end of		
			4 weeks	8 weeks	12 weeks
17	69	2.97	3.06	3.24	3.36
18	62	3.00	3.12	3.36	3.50
19	15	2.75	2.94	3.09	3.30

There is a gradual increase in FVC (L), following deep breathing exercise and it is statistically significant.

STATISTICAL ANALYSIS

	FVC (L) Mean ± S.D	F value (ANOVA)	P value	Significance
Initial reading	3.0 ± 0.7	61.169	< 0.001	Highly significant
End of 4 weeks	3.1 ± 0.6			
End of 8 weeks	3.3 ± 0.6			
End of 12 weeks	3.4 ± 0.6			

*FVC – Forced Vital Capacity

TABLE. 7

VARIATION IN FEV_1* (L) BEFORE AND AFTER DBE

Age in years	No. of students	Average FEV_1 (L)			
		Initial reading	At the end of		
			4 weeks	8 weeks	12 weeks
17	69	2.58	2.78	3.02	3.25
18	62	2.62	2.84	3.10	3.38
19	15	2.34	2.59	2.83	3.12

There is a gradual rise in FEV1 (L) , following deep breathing exercise and it is found to be hightly significant statistically.

STATISTICAL ANALYSIS

	FEV1 (L) Mean ± S.D	F value (ANOVA)	P value	Significance
Initial reading	2.6 ± 0.7	143.439	< 0.001	Highly significant
End of 4 weeks	2.8 ± 0.6			
End of 8 weeks	3.0 ± 0.6			
End of 12 weeks	3.3 ± 0.6			

*FEV_1 – Forced expiratory volume in one second.

TABLE. 8

VARIATION IN FEV_1/FVC (%) BEFORE AND AFTER DBE

Age in years	No. of students	Average FEV_1/FVC (%)			
		Initial reading	At the end of		
			4 weeks	8 weeks	12 weeks
17	69	88.37	91.22	93.72	95.48
18	62	87.60	89.49	93.37	94.58
19	15	85.53	88.40	91.06	94.26

Following deep breathing exercise, there is a gradual increase in FEV1/FVC(%), and it is found to be statistically significant.

STATISTICAL ANALYSIS

	FEV_1/FVC (%)	F value (ANOVA)	P value	Significance
	MEAN ± S.D			
Initial reading	87.8 ± 6.4	161.692	< 0.001	Highly significant
End of 4 weeks	90.2 ± 6.7			
End of 8 week	93.3 ± 4.2			
End of 12 weeks	95.1 ± 3.3			

FIGURE. 3

EFFECT OF DEEP BREATHING EXERCISE ON FEV1/FVC(%)

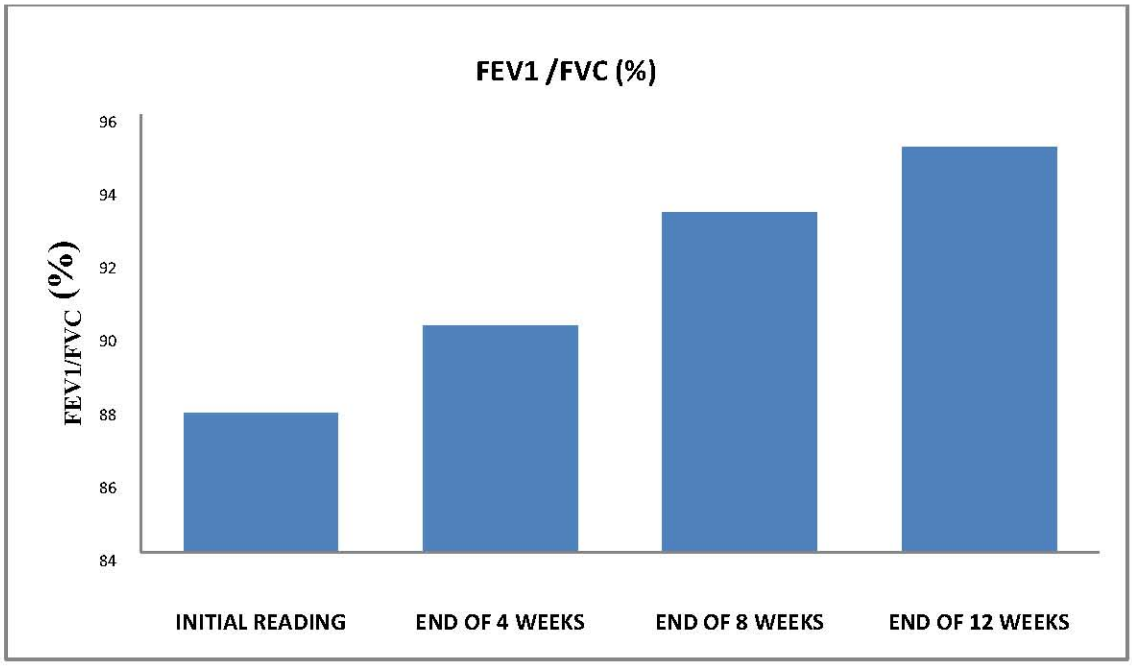


TABLE. 9

VARIATION IN PEF* (L/min) BEFORE AND AFTER DBE

Age in years	No. of students	Average PEF (L/min)			
		Initial reading	At the end of		
			4 weeks	8 weeks	12 weeks
17	69	273.37	293.37	323.89	356.31
18	62	272.33	296.50	335.95	367.85
19	15	239.00	256.00	295.33	333.26

Following deep breathing exercise there is marked increase in PEF (L/min), and it is found to be statistically significant.

STATISTICAL ANALYSIS

	PEF (L/min) Mean ± S.D	F value (ANOVA)	P value	Significance
Initial reading	268.0 ± 87.3	199.868	< 0.001	Highly significant
End of 4 weeks	201.0 ± 90.2			
End of 8 weeks	323.5 ± 79.4			
End of 12 weeks	357.6 ± 76.8			

*PEF – Peak Expiratory Flow

FIGURE. 4

EFFECT OF DEEP BREAHING EXERCISE ON PEF (L/MIN)

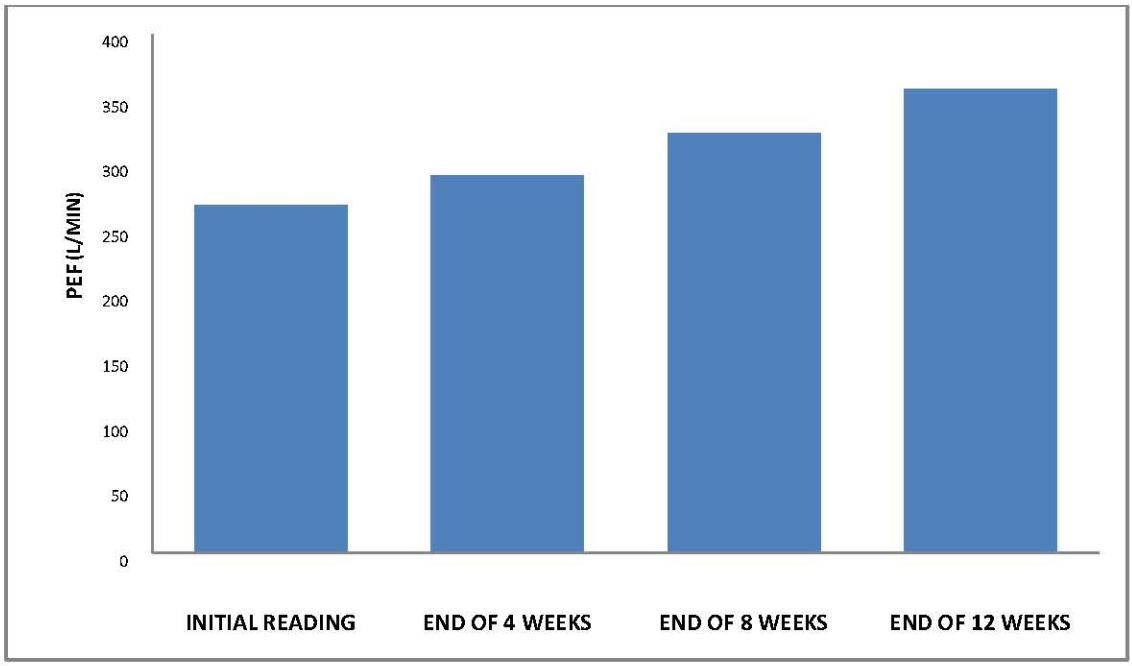


TABLE.10

STATISTICAL ASSESSMENT OF EFFICACY OF DBE ON CARDIOPULMONARY FUNCTION AND ANXIETY LEVEL

VARIABLES	BEFORE (INITIAL READING)	AFTER (END OF 12 WEEKS)	DIFFER--ENCE	t	d.f	P value
	MEAN ± S.D	MEAN ± S.D	MEAN ± S.D			
PULSE RATE (/MIN)	94.8± 10.9	81.4± 8.9	13.4± 8.9	17.302	145	<0.001
SYSTOLIC BLOOD PRESSURE (mm Hg)	120.3± 13.6	110.1± 14.2	10.2± 11.8	10.386	145	<0.001
DIASTOLIC BLOOD PRESSURE (mm Hg)	81.2± 10.4	72.5± 7.8	8.7± 7.8	13.486	145	<0.001
FEV1 (Litres)	2.6± 0.6	3.3±0.6	0.7± 0.5	17.344	145	<0.001
FVC (Litres)	3.0± 0.7	3.4±0.6	0.4±0.5	10.504	145	<0.001
FEV1/FVC (%)	87.8±6.4	95.1± 3.3	7.3± 5.1	17.430	145	<0.001
PEF (Litres/min)	268.0± 87.3	357.6±76.8	89.6± 53.4	19.910	145	<0.001
ANXIETY	5.5±3.3	1.7±1.2	3.8±2.9	16.132	145	<0.001

Discussion

DISCUSSION

The present study involves the measurements of Pulse rate and Blood pressure for the assessment of cardiovascular function and that of FVC, FEV_1, FEV_1/FVC ratio and PEF for the assessment of respiratory function. It is well known that, both cardiovascular and respiratory functions are **regulated** mainly by **autonomic nervous system**, which is a part of central nervous system and they are interlinked. **Hypothalamus**, that is considered as the " Head-ganglion" of autonomic nervous system plays the role of neuroendocrine structure; **structurally** it has **neuronal** elements predominantly, and **functionally** capable of **secreting hormones** like Vasopressin, CRF and other releasing factors that control the hypophysis cerebri, which acts as the "Mastergland of Endocrine Orchestra".

Modern lifestyle mostly sedentary in type, that consists of physical inactivity, overeating, exposure to physical and emotional stress acts to cause anxiety in young individuals. Anxiety, when continued as stress, can cause physiological changes in our body—in the form of sympathetic stimulation with reduction in parasympathetic activity; which in turn, causes alterations in the cardiovascular and respiratory functions. Chronic stress is found to cause stress-related diseases.

In the present study, **anxiety level** in the student volunteers **at the beginning** of the study shows predominant levels—Out of 146 students studied, **only** 2 were of **no anxiety level**, whereas all others had varying anxiety levels. At the end of the study i.e., **12 weeks after Deep breathing exercise**, the anxiety level in all of them was re-assessed and it was found that, there was **significant level** of **reduction in anxiety**. This correlates with the earlier report by Colleen M. Johnson et al 2009.[47] Our brains are only 2% of our body weight, yet they consume 20% of the oxygen we inhale. The shallow breathing associated with stress and negative emotions, reduces the oxygen level of our blood. When there is a slow deep breathing, our body gets enough oxygen and that breaks the stress cycle. **Slow** and **deep breathing** itself has a **calming effect** on the mind and helps an individual to de-stress [48]. This calming effect may also exert profound physiological effects on pulmonary, cardiovascular, and mental functions of the brain.

In our study, there is a significant **decrease** in the **pulse rate** from the mean value of 94.8 to 81.4/min at the end of 12 weeks after the practice of deep breathing exercise. This indicates that, the practice of deep breathing exercise **improves vagal activity**[49]. The systolic and diastolic blood pressure also shows significant change, before and after deep breathing exercise; The mean SBP has reduced from 120.3 to 110.1 mm of Hg and the mean DBP has reduced from 81.2 to 72.5 mm of Hg. Diastolic blood pressure depends on

peripheral resistance and lung inflation has been shown to decrease systemic vascular resistance. This response is initiated by pulmonary stretch receptors, which bring about withdrawal of sympathetic tone in skeletal muscle blood vessels, leading to widespread vasodilatation, thus bringing up decrease in peripheral resistance, which leads to decrease in diastolic blood pressure [40]. The slow **deep breathing enhances the baroreflex sensitivity**, leading to improvement of vagal tone and **reduced sympathetic discharge**, thereby decreasing systolic blood pressure.[50] Our present study correlates well with the study of Grossman A & Grossman E in 2003[51]. Deep and slow breathing found to improve small vessels blood flow and thereby decreases the peripheral resistance, leading to **reduction** in **blood pressure** and pulse rate reduction.[47] A large study of 21,565 subjects practicing deep breathing for 30 seconds induced significant blood pressure decreases in normotensives, untreated and treated hypertensives (Mori et al.,2005)[37] Thus, the reduction in pulse rate and blood pressure found in our study, indicates a **shift** in the **balancing** components of **autonomic nervous system** towards the parasympathetic activity which was reported by Anand BK et al in 1991.[52] This **modulation** of autonomic nervous system activity might have been **brought about** through the conditioning effect of deep breathing exercise on autonomic functions and mediated **through the limbic system** and **higher areas** of central nervous system as reported by Selvamurthy et al.[52] The better response seen in the present study, can be

attributed to more elastic blood vessels and also better reflex activity, which is seen in the younger age group.

Pulmonary function is a **valuable tool** for the **general health assessment**. The mean values of $FEV_{1,}$ FVC, FEV_1/FVC, and PEF were assessed before and after deep breathing exercise. All the parameters were found to be increased significantly indicating the improvement in **efficiency** of **pulmonary** function. The reason could be that, deep breathing exercise causes an **increase** in the **elasticity** of **lungs** and the **rib cage**; there is increased oxygenation of blood, as **alveolar ventilation increases** without changing minute ventilation [39]. The findings correlate with earlier reports. Richa Ghay Thaman et al in 2010 have reported that medical students who had sedentary life-style had lower pulmonary function; physical training and exercise improved the lung function parameters in BSF trainees.[21] K Upadhyay Dhungal et al[40] in 2008 have reported increase in PEFR after slow, deep breathing exercise in young individuals, which also correlates with our finding.

Summary and conclusion

SUMMARY AND CONCLUSION

146 student volunteers, doing the first year M.B.B.S course in Tirunelveli Medical College, Tirunelveli in the adolescent age group (17-19 years) were selected for the study. During this study, the measurement of pulse rate/min, blood pressure (mm Hg) and estimation of FEV1,FVC,FEV1/FVC,PEF were done before and after Deep Breathing Exercise at the intervals of 4 weeks,8weeks and 12 weeks.

The present study indicates that, the anxiety level among the medical students is significantly reduced after deep breathing exercise for 12 weeks—by the findings in Pre-Test and Post-Test with specific questionnaire.

Anxiety, as stress when mild, acts beneficially to improve our activities, by bringing about physiological changes through Psycho-Hypothalamo-Hypophyseal-Adrenal axis as explained by Hans Selye (1907-1982). Stress, when prolonged, interferes with various body regulatory mechanisms resulting in stress-related diseases like hypertension, diabetes mellitus and bronchial asthma. Therefore, to reduce anxiety among youngsters, the deep breathing exercise is found to be very helpful.

The study also reveals the significant reduction in pulse rate (which directly correlates with heart rate) and blood pressure after 12 weeks duration of deep

breathing exercise; this effect is due to **increasing parasympathetic activity**, which is accompanied by **reduction in sympathetic stimulation**, which in turn is the result of reduction in anxiety level in the students. **Sedentary life-Style**, prevalent among modern student population from marked physical inactivity (as a result of lack of exercise, usage of TV and Computers at leisure and working hours) together with anxiety or stress while driving vehicles, facing tests causes **rapid, shallow breathing**; This causes reduction in the vital parameters of pulmonary function, as evidenced by the various studies.

In this study, we find the measurement of Forced Vital Capacity, Forced Expiratory Volume in the first second, Ratio of FEV_1/FVC and Peak Expiratory Flow, done for assessing the **efficacy** of pulmonary ventilation are **significantly raised** after 12 weeks of deep breathing exercise, when compared to those values recorded at the beginning of the study. The changes are due to **slow deep breathing exercise**, which results in better enlargement of thoracic cavity **improving** the contraction of external intercostals muscles and diaphragm, namely respiratory **efficiency,** which is sustained during the day. This deep breathing effort **increases** the **alveolar ventilation**, thereby facilitating diffusion and transport of O_2 and CO_2 across the alveoli. **Better oxygenation** of the blood, that reaches the brain helps in improving the nervous activity, that **reduces** the **anxiety** and its related effects on various systems of the body.

To conclude, this study reveals the usefulness of deep breathing exercise as non-pharmacological adjunct in reducing the anxiety among the students and improving the efficacy of pulmonary and cardiovascular functions. When pursued further, the simple procedure can also help in preventing and postponing the cardiovascular disorders such as hypertension, myocardial ischemia etc.

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Master Chart

MASTER CHART

Sl. No	Age	Sex	BMI	PR(/min)				BLOOD PRESSURE (mm Hg)								LUNG FUNCTION TESTS																ANXIETY SCORE	
								SYSTOLIC				DIASTOLIC				FEV1(L)				FVC(L)				FEV1/FVC(L)				PEF (L/min)					
				Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Pretest	Post Test
1	18	F	19	90	100	90	86	110	110	110	110	72	70	68	68	2.30	2.34	2.34	3.28	2.34	2.36	2.38	3.4	98	99	98	97	260	271	278	292	11	2
2	17	F	21.3	108	88	86	86	128	120	120	120	86	84	80	72	2.64	2.70	2.65	2.83	2.88	2.89	3.00	3.02	92	93	92	94	210	223	230	375	4	1
3	17	F	22	98	92	88	88	150	140	130	120	90	80	80	80	2.44	2.42	2.50	2.59	2.7	2.68	2.70	2.92	90	90	93	89	224	235	240	406	1	0
4	17	F	22.6	110	110	90	88	120	100	100	100	70	76	70	70	2.66	2.72	2.84	3.24	2.8	2.81	2.9	3.26	95	97	98	99	260	283	290	307	9	0
5	18	M	26.2	70	70	70	68	130	120	120	120	84	70	70	70	3.4	3.1	3.12	3.22	3.8	3.14	3.3	3.4	89	92	95	95	280	319	335	391	10	2
6	17	F	17.7	100	96	90	88	120	120	114	110	60	70	70	70	2.63	3.01	3.40	3.68	3.01	3.32	3.50	3.88	87	91	97	97	340	358	360	379	8	3
7	19	F	18.4	112	100	92	90	120	120	120	110	74	80	80	70	1.97	2.21	2.46	2.93	2.80	2.97	3.05	3.31	70	74	81	87	180	193	210	275	8	1
8	19	F	22.2	88	66	68	66	130	120	120	120	86	80	80	80	2.62	2.08	2.74	3.10	3.03	2.30	3.00	3.30	86	90	91	94	150	163	180	225	6	1
9	18	F	22	98	92	78	78	126	120	110	110	90	80	80	80	2.40	2.75	2.8	3.54	2.68	3.00	3.00	3.60	89	92	93	95	280	290	310	382	6	0
10	18	M	25.2	90	78	70	70	158	150	150	148	100	86	84	84	2.68	3.37	3.48	3.69	3.2	3.87	3.6	3.81	83	87	96	97	360	388	420	442	1	0
11	17	M	18.1	102	86	72	72	110	108	110	110	80	70	70	80	3.01	3.25	3.21	3.90	3.32	3.45	3.45	4.00	87	94	93	98	310	323	350	381	9	1
12	19	M	20.7	86	84	84	84	120	110	110	110	84	80	80	80	2.63	3.59	3.71	4.37	3.01	3.80	3.08	4.40	87	94	98	99	290	320	362	405	2	0
13	19	F	25.1	89	72	72	72	140	120	120	120	88	76	74	70	2.21	2.46	2.50	3.01	2.97	3.05	2.71	3.14	74	81	92	98	300	329	360	391	5	2
14	19	F	21.2	110	96	90	88	130	120	120	110	86	78	74	70	2.45	2.63	2.74	3.10	3.02	3.01	3.00	3.28	81	87	91	93	190	230	310	365	10	2
15	19	F	21.8	94	88	88	86	120	110	110	110	80	78	78	80	1.83	1.97	2.21	2.56	2.06	2.83	3.00	3.15	70	70	74	81	140	123	234	270	7	3
16	18	M	19.5	110	104	90	90	120	120	120	120	80	70	70	80	1.44	1.83	2.61	2.84	2.05	2.52	2.99	3.10	70	73	87	91	160	124	252	298	6	1
17	17	F	23.2	90	88	82	82	120	110	110	120	70	68	68	80	2.08	2.41	3.2	3.72	2.30	2.58	3.04	3.81	90	93	94	97	210	247	318	364	6	1
18	18	F	21.7	80	78	78	76	126	120	120	110	76	70	70	60	2.40	2.44	2.63	3.01	2.58	2.52	2.68	3.14	90	97	98	98	182	206	290	303	6	2

Sl. No	Age	Sex	BMI	PR(/min)				BLOOD PRESSURE (mm Hg)								LUNG FUNCTION TESTS																ANXIETY SCORE	
								SYSTOLIC				DIASTOLIC				FEV1(L)				FVC(L)				FEV1/FVC(L)				PEF (L/min)					
				Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Pretest	Post Test
19	18	F	19.5	90	86	86	86	110	110	110	106	70	70	70	66	1.97	2.41	2.63	3.20	2.80	3.29	3.01	3.41	70	73	87	92	125	174	283	321	6	1
20	17	M	19.2	90	84	82	104	120	120	120	130	80	86	80	80	2.44	3.18	3.16	3.78	3.11	3.80	3.51	4.06	78	84	90	93	164	243	264	310	3	1
21	18	F	19.2	100	80	78	96	100	90	90	90	80	60	60	70	1.86	2.12	2.58	2.67	2.18	2.34	2.69	2.75	85	91	96	97	192	202	253	308	7	3
22	17	M	20.8	84	82	80	76	110	100	100	100	68	68	60	60	2.42	2.83	3.25	3.74	2.98	3.41	3.15	3.08	81	83	93	95	210	227	264	311	10	2
23	18	M	22.6	68	68	66	96	140	124	120	140	84	84	80	80	2.18	3.90	3.91	3.96	2.60	4.00	4.01	4.02	84	98	98	99	349	360	398	420	4	1
24	17	F	27.5	98	86	86	80	130	110	110	110	90	80	80	86	1.92	2.09	2.30	3.39	2.14	2.30	2.37	2.45	90	91	97	98	230	252	260	311	2	1
25	17	M	22.2	100	90	88	86	150	140	140	140	96	94	90	90	3.70	3.78	4.67	4.63	2.15	4.06	4.75	4.07	89	93	97	98	291	440	445	331	2	0
26	19	F	24	104	90	86	86	110	100	100	100	70	60	60	60	2.11	1.99	2.39	2.04	2.19	2.07	2.45	2.44	96	96	98	98	230	254	280	293	5	2
27	18	F	15.4	104	102	100	90	100	100	100	90	74	70	68	60	1.61	1.24	1.92	2.84	2.05	2.87	2.29	2.70	79	43	83	84	89	122	212	236	7	2
28	17	F	22.9	112	110	100	92	110	106	100	100	80	80	80	70	2.06	2.24	2.52	2.48	2.38	2.38	2.63	2.54	87	94	97	98	155	256	307	345	11	3
29	17	F	17.2	110	116	98	84	130	116	110	110	80	70	70	70	2.74	2.73	2.39	3.50	2.74	2.75	2.45	3.60	99	99	97	97	303	311	329	341	4	1
30	18	F	17.5	100	96	90	86	106	110	100	100	70	70	70	70	2.18	2.34	2.85	2.81	2.60	2.80	3.34	3.15	84	84	86	89	269	280	310	337	2	0
31	17	F	20.3	100	90	84	84	100	100	96	100	70	60	60	60	1.82	1.76	2.53	3.65	2.19	2.10	2.98	2.15	83	84	92	94	154	161	231	248	4	2
32	18	F	22.3	100	90	90	86	112	110	110	110	70	60	60	60	2.72	2.42	2.57	2.68	2.96	2.88	2.65	2.74	92	84	97	98	160	221	245	281	2	0
33	17	F	15.8	110	104	90	86	90	100	100	90	70	66	60	60	2.39	2.67	3.35	3.52	2.45	2.75	3.66	3.62	98	91	97	97	190	225	256	273	5	2
34	17	M	20.1	96	86	84	84	110	110	110	110	70	70	70	70	2.97	3.4	3.45	3.43	3.23	3.58	3.76	3.05	92	95	97	97	298	328	256	381	3	1
35	18	F	20.6	110	100	90	86	110	110	110	100	60	60	60	60	1.89	1.94	3.26	2.46	2.01	2.15	2.39	2.52	94	90	96	98	149	338	317	325	9	2
36	18	M	22.9	74	72	70	68	120	110	110	110	90	80	70	60	3.25	3.24	3.84	3.98	3.51	3.64	3.09	4.09	93	89	95	97	264	319	364	401	0	0
37	17	M	22.9	92	90	90	80	120	98	90	90	70	68	70	66	2.95	2.68	3.99	3.55	3.44	3.10	3.45	3.81	86	86	91	93	249	307	368	384	2	0

Sl. No	Age	Sex	BMI	PR(/min)				BLOOD PRESSURE (mm Hg)								LUNG FUNCTION TESTS																ANXIETY SCORE	
								SYSTOLIC				DIASTOLIC				FEV1(L)				FVC(L)				FEV1/FVC(L)				PEF (L/min)					
				Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Pretest	Post Test
38	18	M	26.8	100	86	84	82	160	150	140	130	98	80	80	80	2.82	3.35	4.12	4.52	3.28	3.81	4.34	4.98	84	88	91	91	256	328	354	382	3	1
39	17	M	16.2	92	80	80	78	120	100	100	100	76	70	70	70	3.14	3.34	3.50	3.67	3.88	3.72	3.73	3.82	81	90	93	96	418	387	445	462	5	2
40	17	F	20.06	100	100	98	80	116	110	110	100	84	80	80	70	2.59	2.49	2.90	3.29	2.91	2.88	3.09	3.53	89	86	91	93	299	213	326	335	5	1
41	18	M	25	80	76	76	72	110	110	100	96	70	70	70	70	2.20	2.24	2.57	2.71	2.50	2.62	2.76	2.96	88	85	92	94	241	314	381	401	7	2
42	18	F	19.6	90	88	86	86	118	120	116	106	90	80	80	70	3.15	3.27	3.52	3.74	3.51	3.42	3.57	3.8	90	96	98	98	291	370	382	411	3	3
43	18	F	21.1	100	90	90	72	110	100	100	100	80	70	70	70	2.22	2.11	2.71	2.09	2.63	2.73	2.19	3.2	84	77	89	91	148	134	290	310	6	2
44	18	M	16.7	110	104	100	90	110	106	100	100	80	70	70	66	1.90	1.93	2.27	2.54	2.09	2.01	2.39	2.59	91	96	97	98	161	177	262	283	6	5
45	17	F	18.4	86	86	82	72	110	100	100	100	76	70	70	60	2.77	3.00	3.37	3.62	3.61	3.24	3.52	3.8	77	93	95	95	175	205	282	310	10	2
46	17	F	20.6	100	90	90	80	110	100	100	100	80	80	70	70	2.16	2.63	3.59	3.87	3.06	2.93	3.71	3.99	90	90	95	97	380	347	390	404	3	5
47	17	F	24.9	100	98	96	86	116	110	110	110	76	76	76	70	2.47	2.48	3.00	3.37	2.69	2.84	3.22	3.52	92	87	93	95	334	229	371	392	5	2
48	18	F	23.1	92	88	88	86	110	106	106	100	84	72	70	70	2.02	1.94	2.32	2.60	2.28	2.71	2.53	2.18	89	88	92	93	155	161	227	262	5	2
49	17	F	21.6	90	80	80	80	108	106	100	100	80	70	70	70	2.45	2.64	2.94	3.15	3.19	3.24	3.26	3.62	77	81	84	87	162	274	321	361	9	3
50	18	M	22.2	68	60	60	58	130	120	120	120	72	70	70	70	3.71	3.7	2.17	4.30	4.19	4.0	4.36	4.53	89	93	92	93	434	415	462	474	3	1
51	17	M	18.2	80	66	66	76	120	120	120	120	90	78	78	70	3.20	3.17	3.44	3.54	3.43	3.32	3.49	3.59	93	95	98	98	304	289	354	372	7	0
52	18	M	21.5	106	104	100	80	140	120	120	120	110	80	80	80	3.78	3.76	4.00	4.19	4.15	4.13	4.24	4.31	91	91	93	95	443	439	461	483	4	2
53	17	F	29.1	96	84	84	80	120	110	110	120	90	80	70	70	2.42	2.52	2.74	2.83	2.52	2.57	2.79	2.88	96	98	98	98	211	274	301	325	7	1
54	17	F	19.1	78	78	78	80	100	96	90	90	70	70	70	60	2.38	1.98	2.69	2.97	2.69	2.32	3.16	3.23	88	85	89	92	294	154	321	362	1	0
55	18	F	24.6	90	80	80	80	110	110	110	110	70	80	80	70	2.19	2.17	3.00	3.12	2.31	2.27	3.15	3.2	95	96	96	97	167	253	284	312	4	0
56	18	F	19.7	106	90	90	90	120	110	110	110	70	70	70	70	2.19	2.17	2.27	3.34	2.27	2.36	3.39	3.4	96	92	97	98	228	179	264	285	2	0

Sl. No	Age	Sex	BMI	PR(/min)				BLOOD PRESSURE (mm Hg)								LUNG FUNCTION TESTS																ANXIETY SCORE	
								SYSTOLIC				DIASTOLIC				FEV1(L)				FVC(L)				FEV1/FVC(L)				PEF (L/min)					
				Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Pretest	Post Test
57	17	F	21.1	100	86	84	84	130	124	120	120	76	74	70	70	1.64	1.90	2.28	3.11	1.96	2.24	2.64	3.35	84	85	87	93	252	174	214	241	8	1
58	18	F	27.5	82	72	74	84	120	100	106	100	80	70	70	70	1.97	2.32	2.85	3.21	2.80	2.73	3.32	3.52	70	84	86	91	117	148	192	224	10	2
59	17	F	27.5	96	70	70	70	150	130	120	130	120	94	80	80	3.09	3.30	3.57	3.65	3.44	3.53	3.72	3.8	90	93	95	96	262	284	314	334	5	3
60	17	F	22.6	110	100	84	84	130	120	120	120	80	80	80	76	2.32	2.59	3.27	3.34	2.53	2.71	3.39	3.45	92	95	97	97	169	115	215	276	2	0
61	17	F	21.9	110	98	74	82	110	100	100	120	80	70	70	80	2.45	2.90	3.95	4.02	2.68	3.12	4.00	1.2	91	93	95	96	179	211	265	282	5	2
62	18	F	21.6	90	84	80	80	100	110	100	110	90	80	70	70	1.98	2.34	2.61	2.84	2.23	2.58	2.8	3.04	89	91	93	93	136	190	245	261	7	2
63	17	M	15.5	80	76	74	70	126	100	100	110	80	70	70	70	2.52	2.66	2.71	2.82	2.78	2.9	2.9	3	91	92	93	94	334	365	380	410	2	1
64	18	M	20.1	80	76	76	70	100	100	100	96	70	70	68	70	3.84	4.09	4.12	4.31	4.43	4.6	4.6	4.72	87	89	90	91	490	518	484	528	4	2
65	18	M	17.7	100	98	88	78	130	120	110	100	80	80	76	70	2.92	3.10	3.12	3.24	3.15	3.30	3.32	3.4	93	94	94	95	407	410	390	435	4	1
66	17	M	18.7	106	106	100	90	120	110	100	100	86	80	70	70	2.23	4.43	2.54	2.62	2.64	2.77	2.85	2.84	84	88	89	92	148	170	282	290	3	2
67	18	M	26.2	86	86	84	84	110	110	110	100	80	80	80	70	3.63	3.66	3.54	3.92	4.30	4.31	4.4	4.32	84	85	87	91	408	420	434	445	4	2
68	17	F	19.8	100	100	90	90	100	100	100	100	74	70	70	70	2.24	2.37	2.44	2.52	2.36	2.44	2.52	2.6	95	97	97	97	202	236	252	274	4	0
69	18	M	18.1	96	96	90	80	130	130	130	120	80	80	80	76	3.39	3.41	3.52	3.62	3.71	3.66	3.7	3.76	91	93	95	96	332	360	484	492	4	1
70	19	F	18	100	100	90	90	128	120	120	110	70	70	70	66	3.55	2.52	2.55	3.01	1.61	2.6	2.6	3.07	96	97	98	98	149	159	170	210	6	2
71	18	F	22.9	86	86	86	84	110	110	110	110	86	80	80	80	2.18	2.34	2.52	2.66	2.43	2.52	2.65	3.82	90	93	94	94	249	266	190	310	4	3
72	18	M	25.9	88	78	76	70	130	120	120	120	80	80	80	80	2.74	3.03	3.2	3.32	3.15	3.35	3.51	3.56	87	90	91	93	416	433	460	474	7	5
73	17	F	26	116	100	100	98	130	130	130	130	90	90	90	90	2.79	2.92	3.11	3.24	3.23	3.29	3.4	3.54	86	89	91	92	388	391	408	420	4	1
74	17	M	22.2	86	84	84	68	140	140	140	130	100	90	90	90	4.11	4.19	4.22	4.34	4.74	4.78	4.79	4.78	87	88	89	91	464	492	497	510	11	3
75	17	F	22.5	100	100	90	78	124	120	120	120	70	120	70	70	2.45	2.52	2.64	2.17	2.99	3.00	3.05	3.00	82	84	87	90	262	280	310	353	2	1

Sl. No	Age	Sex	BMI	PR(/min)				BLOOD PRESSURE (mm Hg)								LUNG FUNCTION TESTS																ANXIETY SCORE	
								SYSTOLIC				DIASTOLIC				FEV1(L)				FVC(L)				FEV1/FVC(L)				PEF (L/min)					
				Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Pretest	Post Test
76	17	F	18.7	100	96	90	86	120	110	110	106	80	76	70	70	1.81	2.01	2.35	2.55	2.16	2.32	2.55	2.58	84	87	92	99	208	230	252	255	6	2
77	18	M	16.9	84	80	80	78	100	100	100	100	70	70	66	60	3.24	3.32	3.45	3.67	3.85	3.90	3.97	3.99	84	85	87	92	214	234	252	254	4	2
78	17	F	24.2	84	76	76	72	120	110	110	110	80	80	78	70	2.03	2.12	2.34	2.47	2.28	2.35	2.54	2.59	89	90	92	93	252	283	293	311	0	0
79	17	M	20.8	84	70	70	70	120	110	110	96	70	60	60	60	4.03	4.11	4.23	4.47	4.21	4.3	4.38	4.5	96	96	97	99	504	530	564	610	4	2
80	18	M	24.2	92	72	72	72	150	150	150	150	110	100	100	100	3.02	3.33	3.57	3.68	3.61	3.94	4.11	3.99	84	85	87	92	308	340	165	497	5	1
81	19	M	19.8	96	90	86	84	140	130	130	130	110	90	90	90	2.62	2.73	2.84	3.00	3.30	3.30	3.35	3.44	79	83	85	87	248	214	308	221	9	2
82	18	M	22.9	88	88	84	84	126	120	120	120	84	180	80	80	2.98	3.01	3.21	3.31	3.19	3.22	4.41	3.42	93	93	95	97	382	404	410	432	4	1
83	19	F	20.5	88	88	84	84	100	100	100	90	70	70	70	70	2.10	2.22	2.37	2.45	2.56	2.64	2.71	3.55	82	84	87	96	206	236	264	365	6	2
84	17	F	20.9	88	84	84	80	100	100	90	90	80	80	64	60	3.09	3.1	3.11	3.22	3.48	3.45	3.4	3.5	89	90	91	92	274	290	310	324	13	3
85	18	F	17.3	96	86	86	70	100	90	90	90	70	70	70	70	2.10	2.13	2.22	2.41	2.31	2.39	2.45	2.54	91	89	92	95	181	213	280	204	7	2
86	18	F	21.5	90	86	86	84	104	1014	100	100	64	68	66	60	2.43	2.68	2.75	2.84	3.05	3.24	3.2	3.15	80	83	86	90	223	260	305	320	4	1
87	17	F	22.2	100	92	84	80	120	120	120	100	90	80	80	80	2.00	2.21	2.32	2.44	2.37	2.62	2.60	2.67	84	86	89	91	253	257	290	312	3	1
88	18	M	23.1	90	88	78	70	130	130	126	110	88	80	80	70	3.05	3.40	3.57	3.58	4.03	4.20	4.14	4.13	76	81	86	97	214	272	331	471	12	3
89	18	F	21.9	90	90	90	68	110	110	110	100	74	70	64	64	2.20	2.33	2.44	2.57	2.69	2.59	2.60	2.71	83	90	94	95	242	257	289	310	3	1
90	18	M	20.3	86	86	84	64	120	110	110	110	78	70	70	68	3.04	3.15	3.28	3.35	3.44	3.49	3.49	3.54	88	90	94	95	229	360	392	436	4	2
91	17	F	21.5	100	100	100	84	120	120	120	100	70	70	70	68	2.22	2.35	2.45	2.57	2.64	2.56	2.60	2.70	87	92	94	95	289	290	310	342	4	1
92	18	M	16.5	80	80	80	78	130	130	130	130	80	70	70	70	3.04	3.34	3.38	3.65	3.36	3.67	3.63	3.86	90	91	93	95	240	464	472	483	3	1
93	18	F	18	102	100	98	90	120	110	110	100	70	70	70	70	2.31	2.34	2.47	2.59	2.47	2.50	2.56	2.68	94	94	96	97	187	201	278	290	2	0
94	18	M	21.5	80	78	70	70	150	130	130	120	90	90	80	76	3.37	3.54	3.67	3.68	4.16	4.00	4.00	4.02	81	89	92	92	337	370	401	439	18	3

Sl. No	Age	Sex	BMI	PR(/min)				BLOOD PRESSURE (mm Hg)								LUNG FUNCTION TESTS																ANXIETY SCORE	
								SYSTOLIC				DIASTOLIC				FEV1(L)				FVC(L)				FEV1/FVC(L)				PEF (L/min)					
				Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Pretest	Post Test
95	18	M	22.8	94	94	92	88	150	130	130	120	88	80	80	80	3.54	3.71	3.89	3.97	3.90	4.03	4.13	4.18	91	92	94	95	284	310	340	478	4	1
96	17	F	26.2	116	100	78	90	124	120	120	120	86	80	80	80	2.16	2.21	2.32	2.47	2.59	2.64	2.67	2.73	83	84	97	90	313	240	260	305	4	2
97	18	F	21.1	104	96	94	88	110	110	110	100	70	70	70	70	2.62	2.73	2.79	2.87	2.80	2.87	2.94	2.96	94	95	95	97	256	264	279	285	1	0
98	19	F	20.3	100	80	78	78	110	110	110	110	80	80	80	60	2.49	2.64	2.70	2.77	2.77	2.87	2.90	2.92	90	92	93	95	233	249	305	323	6	1
99	19	F	21.8	78	66	66	70	130	120	120	100	70	80	80	70	2.67	2.74	2.94	3.15	2.90	2.95	3.10	3.25	92	93	95	97	237	390	421	452	6	2
100	17	F	24.8	96	90	88	90	130	120	120	120	90	90	90	90	2.51	2.69	2.84	3.05	2.86	2.90	3.01	3.19	90	93	94	96	280	210	256	264	7	2
101	17	F	22.9	88	86	86	86	120	100	100	100	90	70	70	70	2.59	2.84	2.92	3.23	3.05	3.28	3.29	3.54	85	87	89	91	293	310	324	346	6	1
102	17	M	23.1	110	86	84	84	116	110	110	110	88	80	80	70	3.16	3.35	3.54	3.68	3.77	3.67	3.80	3.86	85	91	93	95	415	430	454	467	6	2
103	17	F	16.2	110	102	98	90	120	106	106	100	70	70	70	60	1.82	1.85	2.32	2.41	1.87	1.90	2.36	2.44	97	97	98	99	289	310	334	374	7	1
104	18	M	19.0	104	90	88	106	126	106	106	120	90	70	60	80	3.10	3.18	3.29	3.34	3.52	3.49	3.35	3.54	88	91	93	94	376	412	421	439	5	4
105	17	F	19.3	90	88	86	86	100	106	106	90	68	60	60	60	2.37	2.44	2.52	2.65	2.78	2.85	2.89	2.90	85	86	87	91	249	265	291	308	3	2
106	17	F	21.6	96	86	80	80	100	100	100	90	76	70	70	70	2.55	2.63	2.75	2.98	2.86	2.94	3.00	3.13	89	89	92	95	272	295	331	365	9	2
107	17	M	20.8	82	80	70	70	130	126	120	108	90	86	80	76	3.19	3.34	3.41	3.54	3.48	3.60	3.60	3.68	92	93	95	96	380	394	409	426	3	1
108	19	M	18.8	100	90	78	78	120	110	110	110	78	70	70	70	2.89	3.03	3.12	3.24	3.22	3.30	3.38	3.44	90	92	92	94	353	361	390	410	5	3
109	18	M	18.6	82	70	70	70	120	120	120	110	80	80	80	70	3.15	3.18	3.24	3.41	3.54	3.49	3.51	3.61	89	91	92	94	485	490	511	532	4	1
110	17	F	22.8	88	70	70	66	114	100	100	90	80	80	70	62	1.83	2.24	2.32	2.41	1.98	2.41	2.43	2.50	92	93	95	96	289	310	342	364	1	0
111	17	F	19.1	104	100	100	98	110	110	110	100	90	80	80	80	2.54	2.63	2.75	2.87	2.66	2.74	2.84	2.94	95	96	97	98	334	374	392	410	11	2
112	17	F	22.0	100	104	100	96	120	126	120	110	90	100	90	80	2.53	2.90	3.37	3.56	2.79	3.12	3.49	3.6	91	93	97	98	353	374	391	417	5	1
113	17	M	21.7	90	82	82	80	140	130	130	120	84	98	80	70	2.85	2.90	3.37	3.42	3.17	3.12	3.49	3.50	90	93	97	98	244	289	310	370	2	0

Sl. No	Age	Sex	BMI	PR(/min)				BLOOD PRESSURE (mm Hg)								LUNG FUNCTION TESTS																ANXIETY SCORE	
								SYSTOLIC				DIASTOLIC				FEV1(L)				FVC(L)				FEV1/FVC(L)				PEF (L/min)					
				Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Pretest	Post Test
114	18	F	25.1	90	82	82	82	110	100	110	190	70	68	70	70	2.45	2.56	3.32	3.45	3.02	2.91	3.64	3.70	81	88	91	93	239	252	335	364	8	1
115	18	M	21.9	110	100	96	94	140	130	130	130	90	80	80	70	3.75	3.94	3.95	4.25	4.24	4.08	4.00	4.34	88	97	98	98	374	382	384	421	8	3
116	18	F	21.5	100	100	96	96	130	116	110	100	80	86	86	80	2.42	2.65	2.85	3.12	2.80	2.88	3.08	3.27	86	92	93	95	262	281	290	324	12	2
117	18	F	19.0	84	80	80	80	100	90	100	100	80	78	76	68	2.42	2.50	3.07	3.37	2.70	2.72	3.19	3.47	90	92	96	97	377	360	372	391	9	1
118	17	F	27.5	100	96	94	94	120	120	110	100	90	80	80	80	2.52	3.90	3.27	3.49	2.74	3.12	3.39	3.56	92	93	97	98	325	340	364	382	4	2
119	18	F	19.5	98	88	84	72	110	120	110	100	80	80	78	76	2.00	2.70	3.27	3.32	2.15	2.92	3.39	3.42	93	93	96	97	142	161	241	284	2	1
120	18	F	26.2	110	100	98	90	120	130	130	130	100	90	90	80	1.82	2.33	3.25	3.42	2.41	2.74	3.60	3.68	76	85	91	93	243	252	280	290	4	2
121	17	M	25.8	88	78	76	76	134	126	126	120	90	84	80	80	3.45	3.90	4.10	4.24	3.80	4.12	4.18	4.37	91	93	96	97	427	440	445	484	10	2
122	17	F	19.9	110	100	90	78	100	110	110	100	70	80	80	70	2.10	2.60	2.00	2.87	2.18	2.69	2.15	2.96	96	97	93	97	236	268	214	290	6	1
123	18	F	31.3	110	92	90	86	120	110	110	110	90	80	80	80	2.33	3.03	3.10	3.24	2.74	3.30	3.32	3.42	85	92	93	95	196	215	256	275	3	1
124	19	F	24.6	110	110	100	90	130	120	120	110	90	80	80	80	2.13	2.78	3.25	3.41	2.19	2.83	3.30	3.45	97	98	98	99	240	259	292	310	3	1
125	19	M	21.9	70	60	60	60	150	140	140	140	110	106	100	90	2.90	3.33	3.95	4.24	3.12	3.51	4.00	4.3	93	95	98	99	299	310	344	384	8	3
126	18	M	17.6	76	68	68	68	116	104	110	110	80	70	70	70	3.37	3.78	4.25	2.34	3.49	3.83	4.30	4.41	97	98	98	98	373	394	411	432	1	0
127	17	M	19.4	84	80	80	70	130	120	120	100	90	80	80	70	4.14	4.90	4.78	4.87	4.49	5.12	4.83	4.91	92	93	98	99	281	294	310	344	4	1
128	17	M	18.0	108	100	98	82	130	120	120	100	90	80	80	80	3.24	3.27	3.45	3.57	3.47	3.39	3.50	3.6	93	97	97	99	392	420	445	462	12	5
129	17	M	21.3	82	76	76	76	100	110	100	100	70	70	70	70	2.93	3.23	3.37	3.59	3.20	3.41	3.49	3.63	92	95	97	99	359	362	374	396	16	2
130	18	F	17.3	110	104	100	110	106	90	90	90	70	70	70	60	2.25	2.62	3.10	3.32	2.51	2.81	3.18	3.40	90	92	96	98	272	285	310	347	2	2
131	17	M	21.8	84	76	76	80	120	110	110	110	80	70	70	70	4.20	4.33	4.47	4.59	5.13	4.74	4.49	4.70	82	85	93	98	386	410	401	434	9	3
132	17	F	30.9	110	104	100	78	120	120	120	120	90	84	80	80	2.65	2.73	3.23	3.44	3.00	2.99	3.41	3.54	88	91	95	98	191	215	244	295	6	2

Sl. No	Age	Sex	BMI	PR(/min)				BLOOD PRESSURE (mm Hg)								LUNG FUNCTION TESTS																ANXIETY SCORE	
								SYSTOLIC				DIASTOLIC				FEV1(L)				FVC(L)				FEV1/FVC(L)				PEF (L/min)					
				Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Initial	End of 4 weeks	End of 8 weeks	End of 12 weeks	Pretest	Post Test
133	18	M	17.7	100	68	70	68	116	120	120	120	70	80	80	80	2.66	2.82	3.00	3.35	3.15	3.10	3.15	3.49	84	90	95	96	209	247	265	295	3	1
134	17	F	23.1	102	100	100	72	120	108	100	100	70	68	68	70	2.78	2.80	2.88	3.05	2.83	2.89	2.93	3.10	98	97	97	98	272	294	312	345	5	2
135	18	F	21.2	100	90	80	80	106	110	106	100	74	80	74	80	2.56	2.80	2.23	3.42	2.86	3.02	3.41	3.50	90	93	95	98	224	249	312	392	6	3
136	18	M	23.2	80	78	78	78	130	130	130	130	100	90	90	80	3.64	3.82	3.94	4.14	4.02	4.11	4.23	4.35	91	93	93	95	350	365	370	-	17	6
137	17	M	21.5	100	100	98	90	140	140	140	130	98	70	70	70	2.59	2.98	3.00	3.22	2.78	3.12	3.10	3.30	93	96	97	98	404	410	410	-	1	1
138	18	F	21.9	96	90	88	88	110	110	110	110	78	80	78	76	2.28	2.51	2.55	2.74	4.49	2.56	2.60	2.77	92	98	98	99	304	354	360	370	4	3
139	17	F	32.1	100	82	72	84	138	130	130	120	78	80	78	76	2.35	2.50	2.55	2.72	2.92	2.90	2.92	3.00	80	86	87	90	168	190	210	330	0	0
140	17	F	21.0	100	88	82	84	120	100	96	90	80	76	76	70	2.20	2.32	2.41	2.54	2.45	2.44	2.52	2.58	90	95	96	96	264	280	282	325	5	3
141	17	F	21.5	90	72	70	78	130	120	110	110	90	88	80	80	2.15	2.98	3.11	3.25	2.88	3.12	3.24	3.30	92	96	96	98	404	412	420	432	11	4
142	18	F	21.6	100	90	88	88	120	112	110	110	80	86	80	78	2.51	2.53	2.64	2.77	2.62	2.60	2.70	2.78	96	97	98	99	245	230	232	250	7	6
143	18	M	18.5	100	84	82	80	110	110	110	110	90	80	80	80	2.24	3.33	3.42	3.57	3.69	3.51	3.05	3.61	88	95	98	99	267	480	482	510	4	3
144	17	M	24.6	80	78	78	78	120	110	110	110	78	70	70	70	2.92	3.01	3.41	3.57	4.27	3.33	3.60	3.68	68	90	95	97	233	248	250	294	6	4
145	17	M	20.8	90	80	82	80	120	100	100	100	80	70	70	70	2.12	2.33	2.45	2.73	2.32	2.43	2.50	2.80	91	96	98	98	163	210	215	260	2	2
146	17	F	20.8	70	72	70	80	110	100	100	110	80	80	80	70	2.57	2.62	2.66	3.02	3.24	3.00	3.01	3.29	79	87	88	92	214	220	232	352	5	1